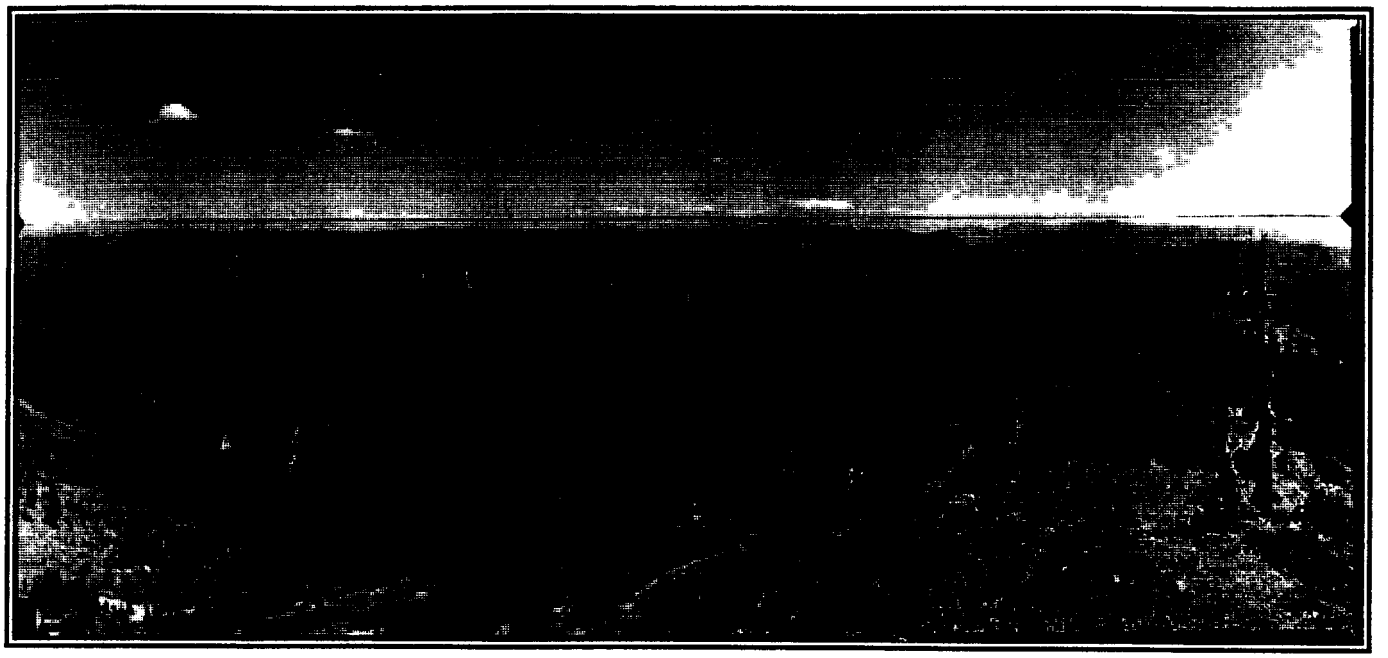
INDIGO CREEK WATERSHED ANALYSIS



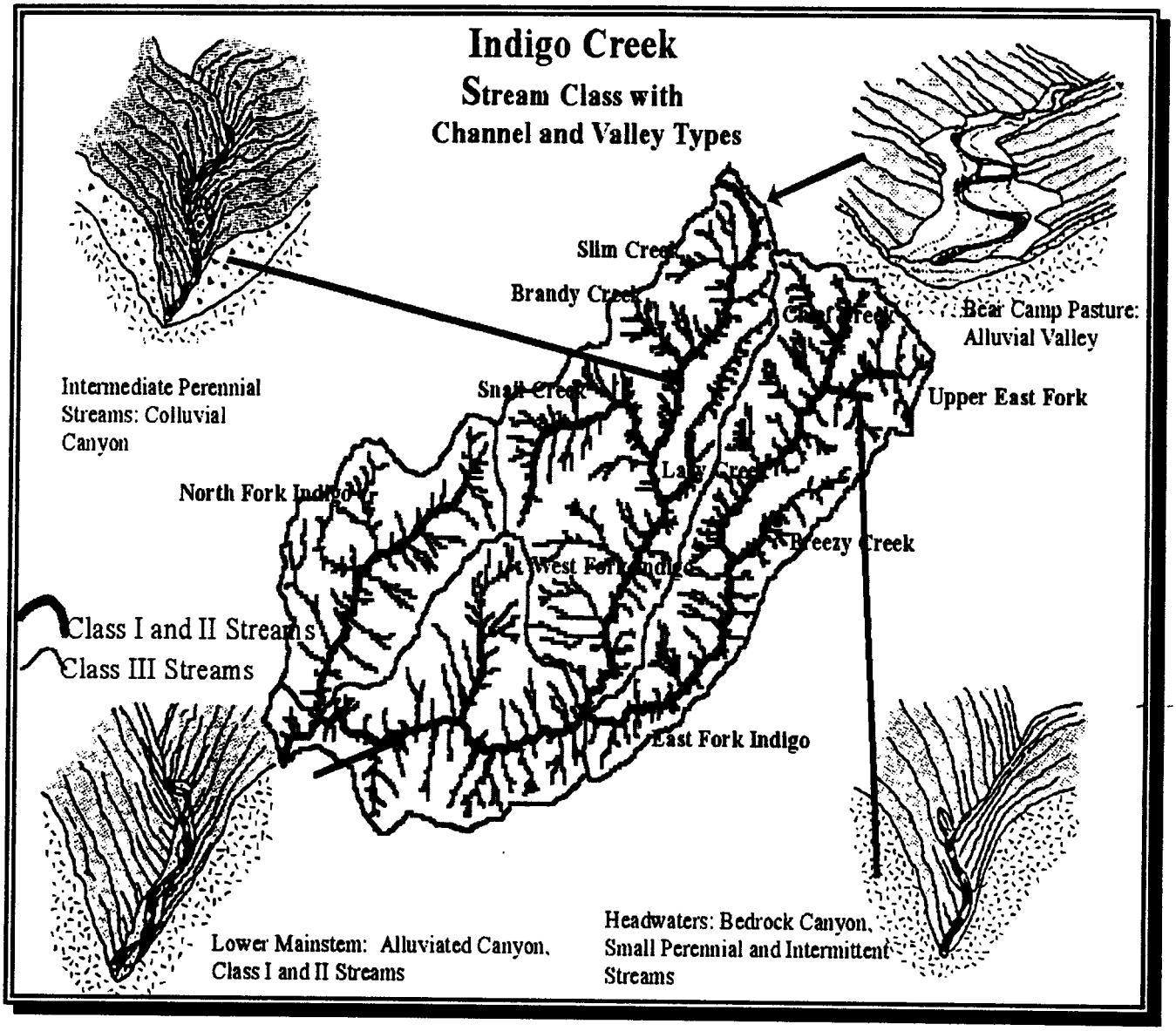
VERSION 1.0

September 15, 1998

GALICE RANGER DISTRICT

SISKIYOU NATIONAL FOREST

INDIGO CREEK WATERSHED ANALYSIS



1.0 WATERSHED OVERVIEW

INDIGO CREEK WATERSHED ANALYSIS

RESPONSIBLE OFFICIAL:

Nancy Rose
District Ranger
Galice Ranger District

PROJECT ANALYSIS TEAM:

Peter Gaulke	*Team Leader*
Randy Frick	*Fisheries*
Steve Tanner	*Vegetation/Plant Ecology*
J. Shibler	*Fire History/Fuels*
Rudy Wiedenbeck	*Soils/Geology*
Howard Jubas	*Hydrology*
Jody Thomas	*GIS Coordinator*
Vince Randall	*Botany*
Randy Miller	*Wildlife*
Diana Perez	*Macroinvertebrate Biology*
Cindy Ricks	*Geology*
Larry Cosby	*Human/Recreation*
Fred Sharp	*Transportation*

ADDITIONAL CONTRIBUTORS:

Bill Blackwell	*Gold Beach Resource Assistant*
Nick Coulter	*Transportation Engineer*
Colin Dillingham	*Gold Beach Wildlife Biologist*
Kevin Johnson	*Westside Resource Geologist*
Chris Park	*Forest Hydrologist*
Connie Risley	*Westside Hydrologist*

NOTE TO THE READER:

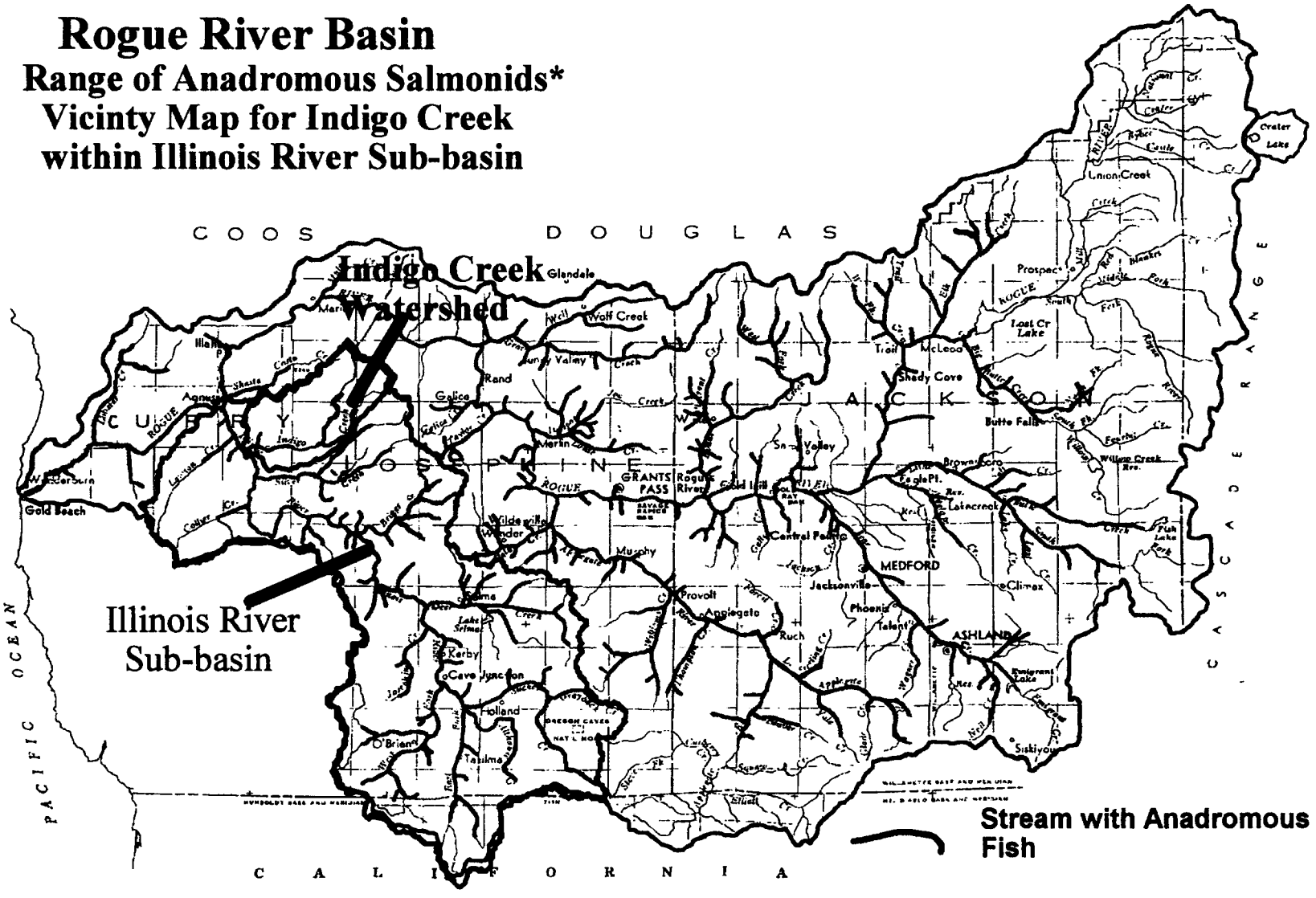
The Indigo Creek Watershed Analysis is the product of resource specialists using their collective professional expertise together with analytical tools currently available on the Siskiyou National Forest. This version of the Indigo Creek Watershed Analysis followed the *Federal Guide for Watershed Analysis, Version 2.2 (Federal Guide)*. Although it is not a decision making document, it is intended as a primary tool for generating information to implement ecosystem management and associated projects as directed by the Siskiyou National Forest Land and Resource Management Plan as amended by the Northwest Forest Plan. As watershed analysis is an iterative process, this document will be updated, as new information becomes available in the future.

ABOUT THE COVER: The Watershed Analysis cover photo was taken May 10, 1934 photo from Fish Hook Peak.

Table of Contents

Rogue River Basin

Range of Anadromous Salmonids*
Vicinty Map for Indigo Creek
within Illinois River Sub-basin



*Based on 1985 State Water Resources Map with updates from Forest Service, BLM and ODFW records- 3/96. Information is not complete.

1.1 MANAGEMENT CONTEXT

The Indigo Creek Watershed is part of the Rogue River Basin in the Oregon Klamath Physiographic Province (ROD, 1994). The Illinois River drains approximately 628,000 acres, or 20% of the 3.3 million acres Rogue River Basin. Indigo Creek Watershed is approximately 49,000 acres (8% of the Illinois River Basin). Ownership within the watershed is predominately National Forest Lands, with a small percentage of the land base held by other landowners (Table 1.1).

TABLE 1.1
MANAGEMENT AREA ALLOCATIONS

Management Area	Acres
MA 2 - Wild River	45
MA 4 - Botanical	193
MA 6 - Backcountry Recreation	750
MA 9 - Special Wildlife Site	532
MA 11 - Riparian Reserve	668
MA 13 - Partial Retention Visual	350
MA 14 - Matrix	2,529
Private/BLM	2,807
Late-Successional Reserve (LSR)	41,190
TOTAL	**49,064**

The Indigo Creek watershed traverses two administrative boundaries of the Siskiyou National Forest, and includes a portion of Bureau of Land Management lands. (Table 1.2)

TABLE 1.2
ADMINISTRATIVE ALLOCATIONS

Administrative Unit	Acres
Galice Ranger District	30,541
Gold Beach Ranger District	18,260
Bureau of Land Management	263

The Siskiyou National Forest Land and Resource Management Plan, as amended by the Record of Decision for Amendments to Forest Service and Bureau of Land Management Planning Documents Within the Range of the Northern Spotted Owl (USDA, USDI, 1994), has created management allocations on Federal Lands within the Watershed. These allocations define the type of management activities on Federal Lands.

Management direction in the Northwest Forest Plan (NWFP) identified the Indigo Creek Watershed as a key watershed. As identified in the NWFP as well, approximately 84% of Indigo Watershed is contained in the Fish Hook/Galice Late Successional Reserve.

A recently completed Wild and Scenic River Eligibility Study has found that the Indigo Creek is eligible for Wild Status with an Outstanding Remarkable Value (ORV) for anadromous fish.

1.2 THE SETTING

Indigo Creek is a major tributary and contributor to the water quality of the Wild and Scenic portion of the Illinois River. At the confluence of the Illinois River, Indigo Creek contributes approximately 10-20% of the total Illinois River flow. The main tributaries of Indigo Creek are Snail, Lazy, West Fork, East Fork, North Fork, Breezy, Brandy, Chief and Slim Creeks.

Elevations range from 350 feet above sea level at its confluence with the Illinois River to 4500 feet at Bear Camp Pasture. There are approximately 50 miles of fish bearing totaling 4,153 riparian reserve acres in the watershed; and 203 miles are perennial that total 7,737 riparian reserve acres. There is also an estimated 267 miles of intermittent streams totaling 11,262 riparian reserve acres. Riparian Reserve widths were calculated as defined by the Northwest Forest Plan, using an average potential site tree height of 160 feet. Approximately 71% of the watershed is currently in Riparian Reserves.

1.3 CLIMATE

The climate in Indigo is characterized as cools wet winters and warm dry summers. The average annual precipitation ranges from 90-120 inches. Most of the rainfall occurs between November and March. From 1985 to 1994 this area has been in a drought state. Since 1994, rainfall has been normal. Recently there have been two storms of significant magnitude. In 1995 a winter storm flows ranged from a 5 to 25-year return interval and in the winter of 1997 a storm flow ranged from a 10 to 50 year return interval. Winter flows vary from 50 to 2000 cfs during events with less than a 5-year recurrence interval.

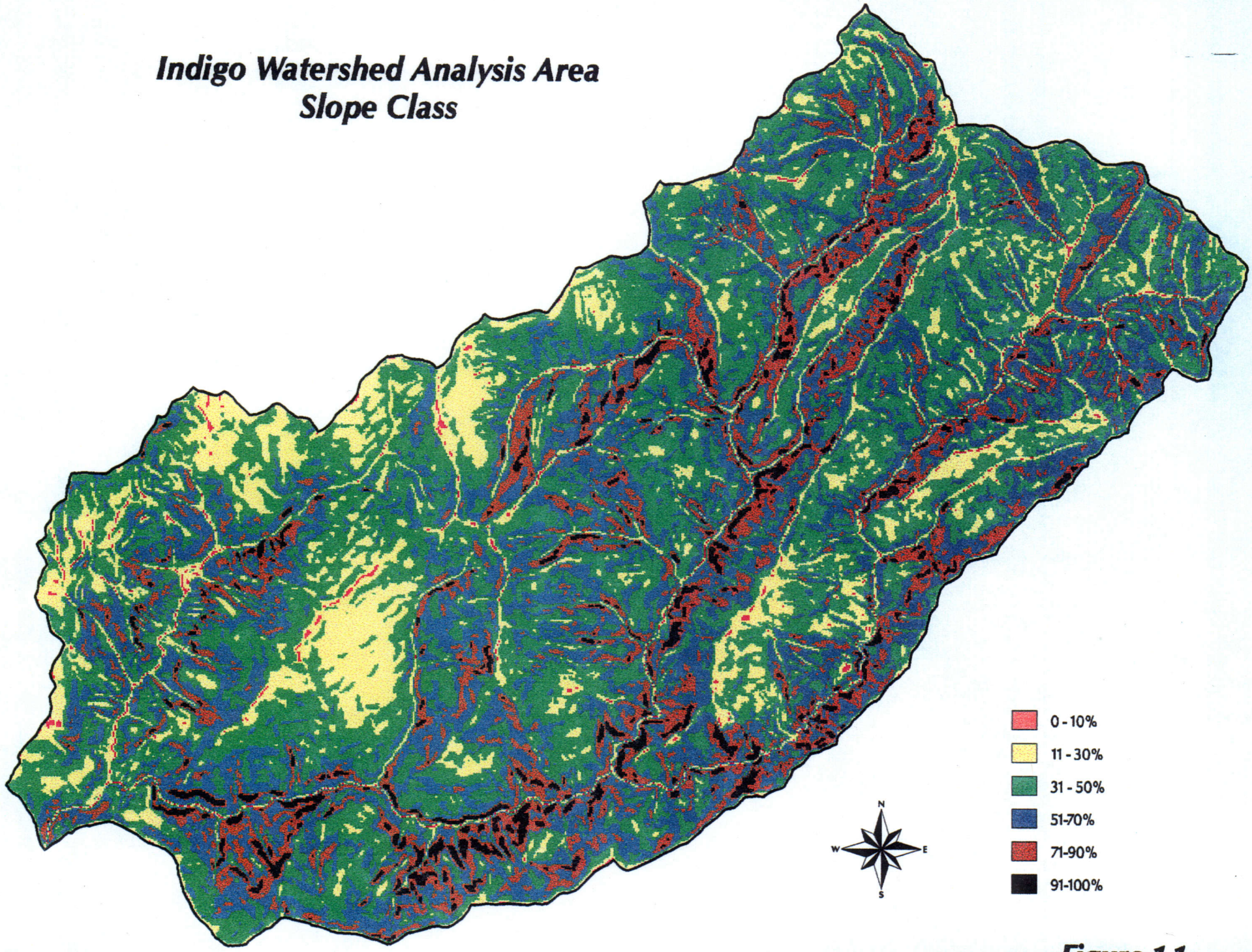

Indigo Watershed Analysis Area
Slope Class
0 - 10%
11 - 30%
31 - 50%
51-70%
71-90%
91-100%
N
W
E
S

Figure 1.1

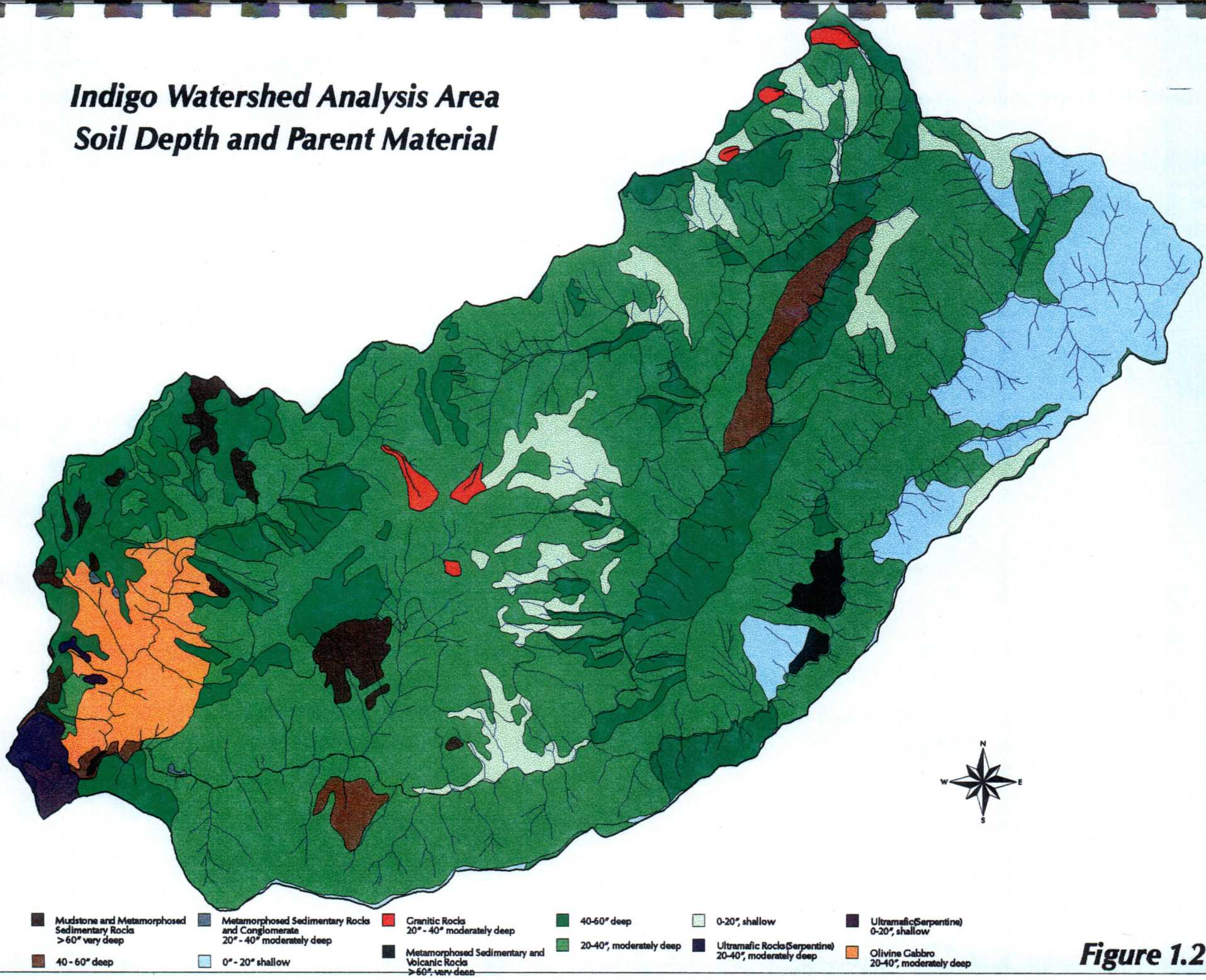

Indigo Watershed Analysis Area
Soil Depth and Parent Material
N
W
E
S
Mudstone and Metamorphosed Sedimentary Rocks >60" very deep
40 - 60" deep
Metamorphosed Sedimentary Rocks and Conglomerate 20" - 40" moderately deep
0" - 20" shallow
Granitic Rocks 20" - 40" moderately deep
Metamorphosed Sedimentary and Volcanic Rocks >60", very deep
40-60" deep
20-40", moderately deep
0-20", shallow
Ultramafic Rocks (Serpentine) 20-40", moderately deep
Ultramafic(Serpentine) 0-20", shallow
Olivine Gabbro 20-40", moderately deep

Figure 1.2

1.4 GEOLOGY, SOILS & LANDFORMS

The dominant rock types underlying the watershed are graywacke sandstones and mudstones of the Dothan Formation (equivalent to the Franciscan Formation of California). Although few faults are mapped within the Dothan Formation, faulting is abundant and associated with deeper weathering and soils. Mapped faults occur in the western part of the watershed (Ramp, et.al., 1977). Metamorphosed gabbro is exposed in the North Fork Watershed and is faulted against the Dothan and overlain by younger mudstones of the Lookingglass Formation (Eocene). A small exposure of ultramafic rocks (serpentine) underlies the prairie near the mouth of Indigo Creek. In the East Fork Watershed, a thrust fault separates the Dothan from igneous quartz diorites and rhyodacite flows and bedded tuffs (Smith et.al., 1982).

Glacial landforms occur as cirque basins in the headwaters of Slim, Brandy, and Snail Creeks, and at Bear Camp Pasture (USDA, 1994). A glacial deposit (moraine) was also mapped in the uppermost portions of Snail Creek at 3800-3200 feet elevation in a U-shaped valley below a cirque basin in the head of the watershed (Henkle, 1990).

The Indigo watershed includes some of the steepest terrain on the Siskiyou National Forest. The Siskiyou Forest Plan lists this planning basin as having 17% of its slopes steeper than 55% gradient, ranked 4th among all of the basins. The slope map (Figure 1.1) illustrates the inner gorges, where slopes are steeper adjacent to stream channels. Some of these inner gorges are among the longest observed on the Forest.

Soil productivity is closely associated with soil depth and therefore varies with bedrock weathering resistance and slope. Rocky ridges and outcrops, as well as surface "rock mulch" areas are common on the sandstone. Soils in the watershed tend to be shallow (Figure 1.2), mapped primarily as moderately deep (20-40 inches) and as shallow (0-20 inches). Soils derived from sandstones are loamy and often have abundant gravel-sized fragments. Soils on the steep slopes are commonly rated with a severe erosion hazard. The most extensive soil complexes involving rock outcrops are located at Sugarloaf Mountain and the south-facing slopes of Fish Hook Peak. In the upper East Fork, the most prevalent soil is a shallow, extremely gravelly loam (Vermisa series; SCS, Soil Survey Josephine County). The soil is excessively drained with limited available water and production potential. [Note that parent materials mapped in Figure 1.2 may not match the actual bedrock as mapped by Ramp, et. al. (1977) and Smith et. al. (1982), due to correlation of soils developed on parent materials in other areas.]

The mudstone bedrock is more easily weathered and tends to underlie more gentle slopes. Some of the mudstones with deeper soils have well-developed clay loam subsoils and are among the most productive in the watershed (eg. Atring and Kanid series; NRCS, in press, Soil Survey, Curry County). Some of these soils are developed on colluvial deposits from extremely large, ancient landslides. The very deep soils on footslopes in the East Indigo Creek watershed downstream from Breezy Creek (Figure 1.2) have these characteristics.

Effective moisture for soil development is greater to the west of the Brandy Peak divide, with a rain shadow over the West and East Forks of Indigo Creek (Plant Association Guide for the Siskiyou Province, 1984). The North Fork Indigo watershed has the largest area of deep soils as well as higher moisture.

Forest lands that are deemed unsuitable for timber harvest are classified as Timber Marginal Reforestation (TMR), Timber Marginal Lands (TML), and Timber Marginal General (TMG) (Figure 1.3 and Table 1.3). Half of the acreage in the West Fork watershed is unsuitable, including 12% in TML due to unstable slopes. Only 3% of the North Fork is mapped as unsuitable, for the reasons described above, and because additional unstable slopes in the watershed have yet to be mapped (data gap). The East Fork has the highest proportion of TMR, 30%, resulting from the shallow Vermisa soils, and shallow soils along the ridge east of Buck Camp.

Because of the relatively steep and active slopes, most slopes have not developed residual soils with high clay content (Figure 1.4). Where soils have been disturbed by landslides, erosion, or road

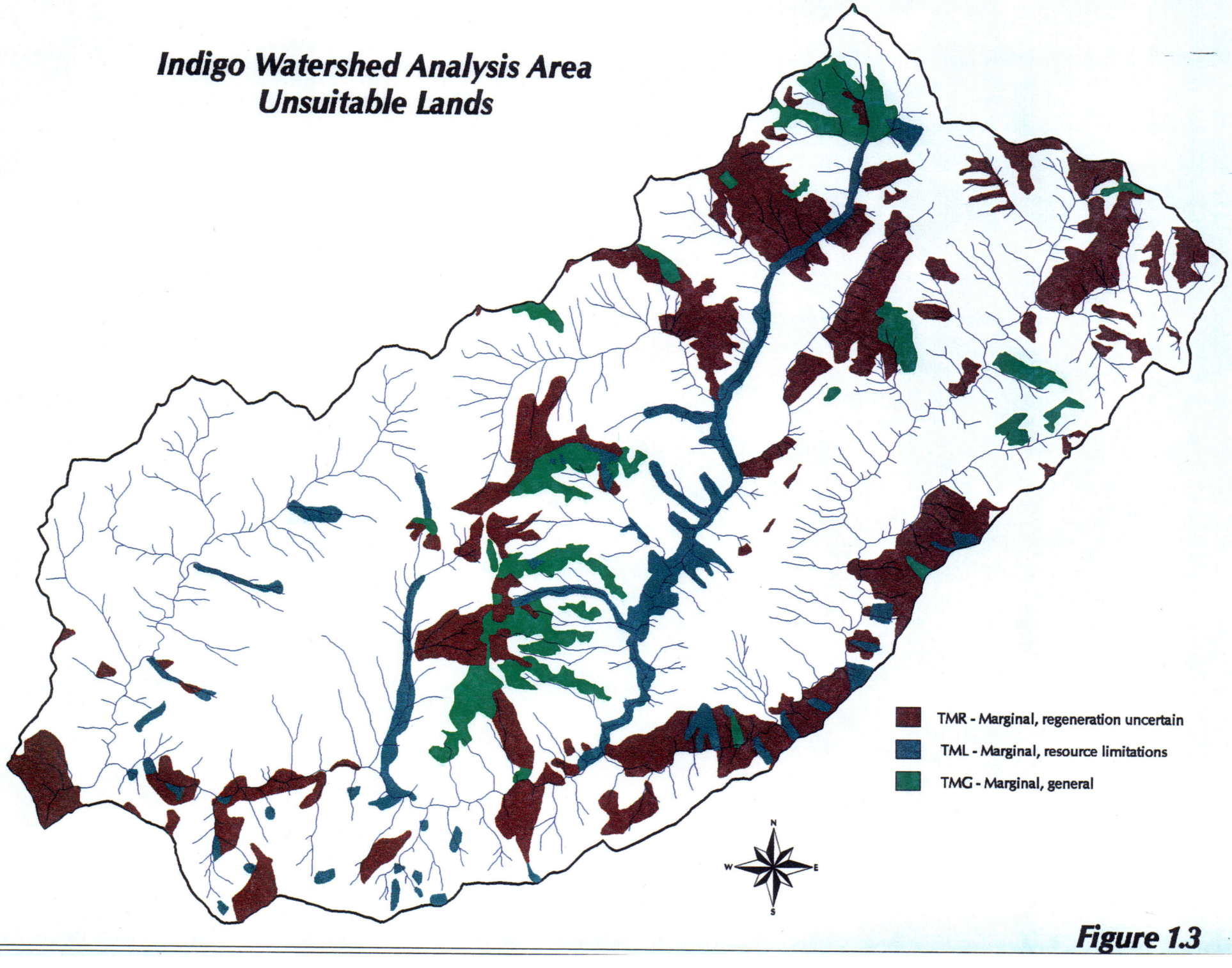

Indigo Watershed Analysis Area
Unsuitable Lands
TMR - Marginal, regeneration uncertain
TML - Marginal, resource limitations
TMG - Marginal, general
N
W
E
S

Figure 1.3

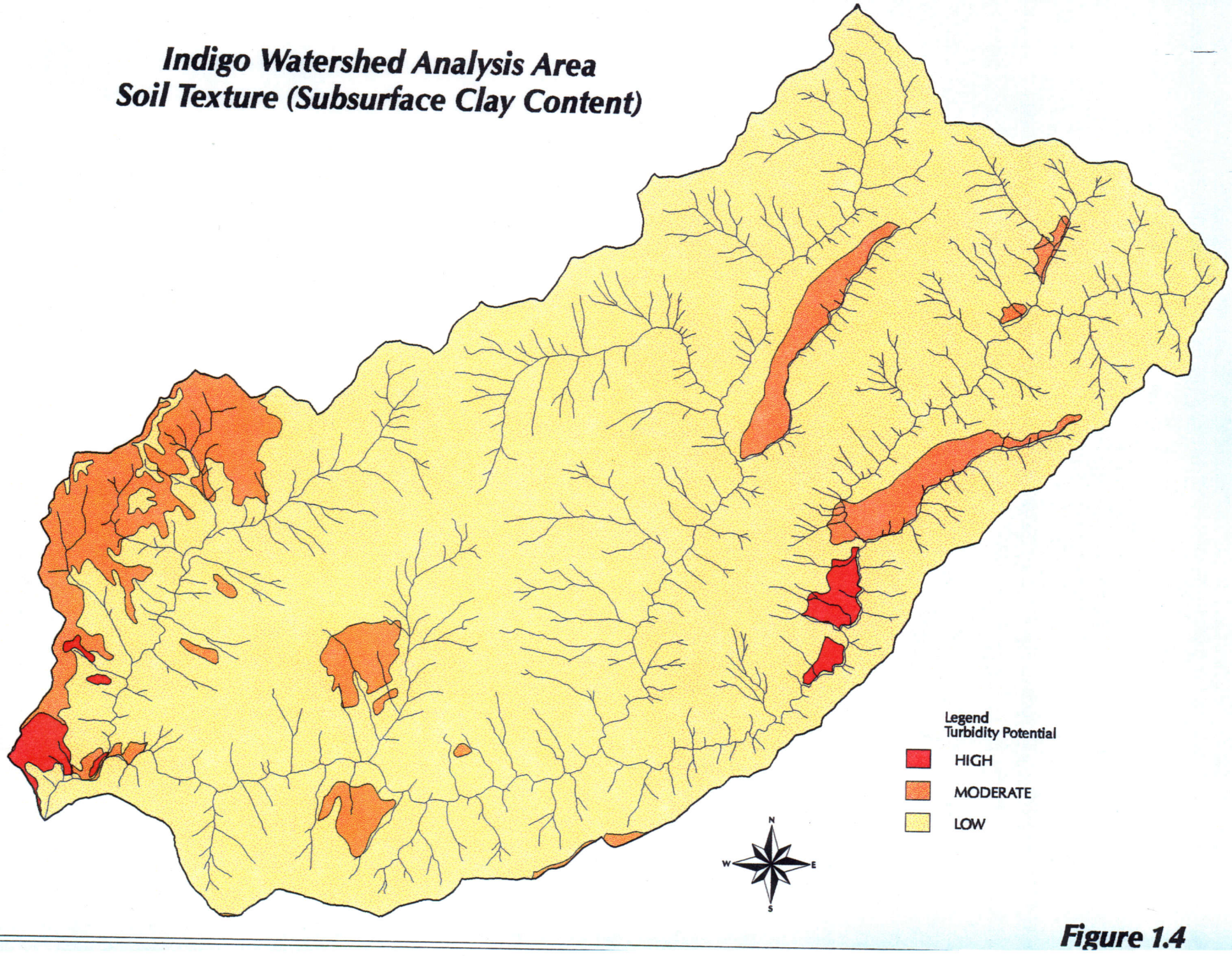

Indigo Watershed Analysis Area
Soil Texture (Subsurface Clay Content)
Legend
Turbidity Potential
HIGH
MODERATE
LOW
N
W
E
S

Figure 1.4

construction, flowing water will entrain sediment that has low turbidity due to the low clay content. Even with the low clay content, where large volumes of fine-textured sediment have been delivered to streams, turbid water may result.

TABLE 1.3
UNSUITABLE, MARGINAL AND SENSITIVE LANDS

	TMG	TML	TMR	Basin Total
East Fork	4.2%	2.9%	30.3%	37.4%
West Fork	12.5%	12.0%	25.4%	49.9%
Lower Indigo	3.98%	5.7%	21.0%	30.7%
North Indigo		2.25%	0.6%	2.85%

1.5 CHANNEL MORPHOLOGY AND WATER QUALITY

Mainstem Indigo Creek has a west to southwest orientation. Moderately entrenched streams in narrow canyon gorges characterize the watershed with moderate to steep slopes in association with terraces. The high terraces are elevated 20 to 50 feet above the stream. The inner gorges are 50-200 feet wide and up to several hundred feet high. Natural landslides and resulting landslide dams have been historically responsible for catastrophic debris flows and flash floods and are one of the processes for delivering sediment.

Indigo Creek, a fifth field watershed, is a major contributor to cooling of the Illinois River. It has been listed as water quality limited for summer stream temperature on the main stem (Oregon List of Water Quality Limited Water Bodies 303 (d)(1) List, December, 1996). Generally, low elevation streams in this latitude, with watersheds greater than 15,000 acres have summer water temperatures which exceed the state standards. Stream temperature modeling on Lawson Creek, a 25,241 acre coastal tributary to the same segment of the Illinois River, suggests that historic stream temperatures were above state standards and within the range of current temperatures conditions. It is speculated that Indigo Creek, as with Lawson Creek, would have had stream temperatures which exceeded the current state standard prior to any management activities.

1.6 FISHERIES

Indigo Creek is a major tributary and contributor to the water quality and anadromous and resident fisheries of the Wild and Scenic portion of the Illinois River.

Indigo Creek watershed contains the following fish species: fall chinook salmon, winter steelhead trout, resident and searun cutthroat, rainbow trout and sculpin. Steelhead and rainbow trout are the dominant salmonid species in this watershed. About 20-25 miles of stream habitat in Indigo Creek are accessible to steelhead, varying with streamflow and changes in the stream channels of the watershed. Approximately an additional 7-10 miles of streams in the watershed contain resident cutthroat and rainbow trout populations. Rainbow and cutthroat trout can contribute to anadromous populations by migrating to the ocean from above and below apparent migration barriers. Indigo Creek is a key watershed in the Northwest Forest Plan.

The majority of the watershed is now under a Late Successional Reserve allocation that affords future protection for anadromous fish. Steelhead trout have been deferred from listing under the Endangered Species Act in the Klamath Mountains Province Evolutionary Significant Unit (KMP ESU). They are sensitive species on the R6 Regional Forester's Sensitive Species list, as are all salmonids, and are candidate species for listing under the Endangered Species Act.

1.7 TERRESTRIAL

The Indigo Watershed contains a diverse assortment of plant communities. Aspect, elevation, slope, parent material, soil depth, climate, fire history, past management activities, and a variety of hydrologic regimes combine to produce a wide variety of habitats for plant communities. These communities include coniferous forests, hardwood forests, mixed conifer/broadleaf hardwood forests, rock outcrops, ridges, and screes, brush fields, riparian areas, wet meadows, seeps, and bogs, dry meadows and grassy areas and open woodlands.

1.7.1 Plant Series

The Indigo Watershed contains four plant series. These are Douglas-fir, white fir, tanoak, Douglas-fir tanoak. Over 60% of the watershed is composed of

Douglas-fir or Douglas-fir tanoak plant association. White fir and tanoak contain less than 20%each of the acreage of the watershed

1.7.2 Tree and Shrub Species

Douglas-fir is the most common overstory tree found in the Indigo Watershed and is frequently associated with other conifers, including sugar pine, knobcone pine, white fir, Shasta red fir, incense-cedar, western hemlock, Port-Orford-cedar, and Pacific yew. Associated hardwoods include Pacific madrone, tanoak, golden chinquapin, bigleaf maple, red alder, canyon live oak, Oregon white oak, and California black oak.

Common shrub species include tanoak, Sadler oak, canyon live oak, poison-oak and several species of manzanita and Ceanothus. Species such as Pacific rhododendron, salal and sword fern are found most often on cooler sites and within riparian zones.

1.7.3 Seral Stage

The vegetative cover of the Indigo Watershed features considerable diversity in terms of plant communities and seral stages. Of the major seral stage groupings that occur within the watershed, 28% are occupied by late-seral forest stands. This stage includes mature and old-growth conditions. Approximately 18% of these lands are occupied by mid-seral forest stands, which typically occur from ages 40 through 120 and feature stand diameters of 12 inches or greater. Approximately 27% of lands are occupied by early seral vegetation, including pioneer and early seral. Approximately 23% of lands are occupied by pioneer seral vegetation.

Approximately 4% of lands within the Indigo Watershed are not capable of developing continuous forest cover and consequently do not exhibit a great deal of vegetative change over time. Surface rock, extremely skeletal soils, low shrubs, and very sparse tree cover are characteristic of such non-forest lands.

1.7.4 Botanical Species

The Indigo Creek watershed contains the largest known population of *Bensoniella oregana* and *Frasera lobbii* on the Siskiyou National Forest. *Frasera lobbii* has a final management plan written which was written cooperatively by the U.S. Forest Service and Bureau of Land Management. *Bensoniella oregana* has a draft management plan written and available.

The probability is large that not all non-native grasses or other introduced species within these watersheds are known, however, there are several that have been identified. Introduced "weed" species include yellow starthistle (*Centaurea solstitialis*), Scotch broom (*Cytisus scoparius*) and Klamath weed (*Hypericium perforatum*).

1.7.5 Wildlife Species

Indigo Creek contains over 200 vertebrate and many more invertebrate species. Deer and elk are abundant and northern spotted owls and peregrine falcons are present. Little is know about the distribution and abundance of most species. However, considerable amount is known about habitats that wildlife use, and the distribution and abundance of these habitats.

Regeneration timber harvest and fire have had the greatest impacts on wildlife habitats in the watershed, particularly old growth forests. With the current land allocations old growth is expected to recover and grass, forb and shrub habitats are expected to decline. Abundance of old growth dependent species like the northern spotted owl would be expected to increase while grass, forb and shrub associated species, like deer and elk, would be expected to decline.

1.8 NATURAL AND HUMAN DISTURBANCE

1.8.1 Fire

The Silver Fire of 1987 covered approximately 37% of the watershed, affecting riparian, mid-slope and upland vegetation. Approximately 15% of the stand acres in the Indigo Watershed's Silver Fire Area burned at a high intensity where nearly all above ground vegetation was consumed. This resulted in these stands reverting back to a pioneer seral stage.

1.8.2 Roading

The road system in this watershed is served by two (2) major road systems. Josephine County Road No. 2400 (Merlin-Galice road) and Curry County Road 595 (Jerrys Flat road).

Within the watershed there are approximately 111 miles of existing road today. This is 4% of the total

forest road system and 13% of the total Galice Ranger District system and 6% of the total Gold Ranger Beach District system. The highest density of roads in the watershed is found in Snail Basin.

Since the advent of the Northwest Forest Plan and following guidance of the Siskiyou National Forest's Transportation Needs Assessment, an extensive road decommissioning program has been implemented. The term decommissioning refers to closing and hydrological restoring a road system. Table 1.4 summarized the total road miles decommissioned in the watershed. It is proposed that additional 6.35 road miles be decommissioned in FY98.

TABLE 1.5
DECOMMISSIONED ROADS BY RANGER DISTRICT
(Roads decommissioned by the end of FY97)

District	Miles
Gold Beach	17.63
Galice	7.91

1.9 HUMAN CHARACTERISTICS

The Indigo Creek watershed has a high percentage, by area, of unroaded, non-wilderness, and primitive rugged terrain. Over recent years, and currently this is a disappearing resource in Oregon.

1.10 KEY QUESTIONS

Key analysis questions were formulated from indicators commonly used to measure and interpret the key ecosystem elements. Developed from issued raised specific to Indigo Creek, the following "Key Questions" were formulated as a guide to focus this watershed analysis.

1) What type of local employment has the Indigo Creek watershed contributed in the past, present, and is expected to do in the future? Related activities are tourism, timber products, fishing, mining, special forest products, and outfitter guides.
2) How does Indigo Creek watershed provide for amenity values? Is there a difference between past, present, and future values? These are values related to scenery, wilderness, solitude, and related activities.
3) What is the past, present, and future recreation use of the watershed?
4) How has the watershed been accessed in the past, present and what are the future needs?
5) What are the measurable factors that affect the watershed's ability to sustain Threatened and Endangered species?. How can habitat be maintained or improved?
6) What are the factors that sustain a genetically diverse and demographically healthy population of plant and animal species?
7) What are the historic disturbance patterns for the Indigo Creek watershed? How has management activities affected these patterns? What is the ability of the Watershed to sustain disturbances?
8) What are the historic cycles and amounts of large woody material in the watershed? What are the processes that deliver large wood and where do they occur? Where have management activities changed the large wood supply below historic levels? Are there areas of concern for future wood supply and should and can the supply of large wood be restored?
9) What are the processes that deliver sediment, and where do they occur?
10) What processes reduce shade and increase stream water temperature and where do they occur? Where have management activities increased solar exposure and stream water temperature? Where are fish habitats sensitive to increased stream water temperatures? What are the future trends in stream temperature and can they be improved?
11) What processes have the potential to change the magnitude and frequency of stream flow?
12) Where are channels sensitive to increased sediment and decreased large wood? Is there evidence that channel morphology and sediment storage have changed form historic conditions? What are the expected channel morphology and storage condition trends? How can the channel conditions be improved?
13) What fish species inhabit the watershed? Are these different from the historic species? What are the current fish habitat conditions? This can be expressed basinwide and in susceptible reaches. Is there evidence that fish habitat conditions have changed form historic levels? What are the expected trends in fish habitat conditions? How can the fish habitat be improved?

1.11 KEY FINDINGS

A Finding is knowledge that was generally unknown or has been confirmed through watershed analysis. Findings are facts that are reasonable inferences based upon all the relevant information.

The following Key Findings, which are grouped by module, resulted from the Indigo Creek Watershed Analysis;

1.11.1 Aquatic Module Findings

1) The Indigo watershed includes some of the steepest terrain on the Siskiyou National Forest. The inner gorges, where slopes are steeper adjacent to stream channels, are among the longest observed on the Forest.
2) Landslides dominate the sediment delivery processes with inner gorges being the most common locations for debris slides. A number of the pre-1940 landslides exceeded one million cubic yards in volume. The 1964 storm was the trigger for most of the landslide sediment delivery to streams during the period from 1940-1988.
3) Some deep soils with well-developed clay loam subsoils have developed on colluvial deposits from extremely large ancient landslides, and are among the most productive in the watershed.
4) Although roads contribute a minor part of landslide sediment to stream channels in this watershed, many of these roads were not constructed at the time of the 1964 storm.
5) The supply of large wood to the mainstem is greatest to least from the North Fork, West Fork, and East Fork, based on the proportion of late/mid, early, and pioneer seral/structural stages in riparian areas.
6) Management activities including timber harvest and road construction have had little effect, except locally, on the stream channel, see Hydrology subwatershed section. The Indigo watershed has had a rich history of natural disturbance that has played a role in forming the channel and its present condition.
7) The 1988-1993 macro-invertebrate studies in Indigo Creek watershed indicate that the aquatic invertebrate community is in good to excellent condition. This study is an indication of condition of water quality. The study suggests that water quality is not a limiting factor for cold water fish.
8) Summer water temperatures are warmer than optimum for fish survival and success on the lower mainstem of Indigo Creek.
9) Although it is not known what the overall historic quantity of large wood is in Watershed 6, it is known that current levels are often lower than levels documented as healthy by old growth standards (Swanson et. al, 1978).

1.11.2 Terrestrial Module Findings

1) Development of late-successional habitat can be accelerated through treatment of managed and natural stands in late-successional reserves, riparian reserves, and other allocations not programmed for timber harvest.
2) The highest priority for stand treatment to improve late-successional habitat is those stands that are adjacent or within late-successional blocks, or stands those that are under the heaviest competition from high stand densities.
3) Several managed stands within the Silver Fire area have been identified as severely limited by brush competition and are high priority stands for stand management.
4) To meet desired/reference conditions in the watershed, habitat elements detailed in Appendix A, Table 20 should be maintained and restored.
5) White oak/black oak meadow habitat is being lost due to encroachment from conifer trees and the exclusion of fire.

1.12 MANAGEMENT RECOMMENDATIONS

1.12.1 Aquatic Module Recommendations

1) Conduct a field inventory of fill stability, drainage spacing and outlet erosion, and diversion potential to determine if a landslide or erosion hazard actually exists on high priority road segments (included on list and map)
2) Transfer watershed sensitivity map from Silver Fire Recovery Project into GIS. Debris flow source areas at the heads of channels are critical to include within Riparian Reserves to protect the supply of large wood.
3) Conduct historic landslide inventory in North Fork Indigo Creek subwatershed. Add unstable areas to Forest layer of unsuitable for timber harvest due to irreversible soil loss (TML)

4) Transfer geologic maps from available sources, including Josephine County (Ramp et. al., 1977) and Medford 1 x 2 degree quadrange (Smith et. al., 1982) to GIS. This mapping will improve interpretations of soil productivity, particularly in upper East Fork Indigo.
5) Continue Level 2 stream surveys on a 5-10 year basis to quantify habitat conditions as restoration work continues. Investigate the possibility of employing stream reach no. 2 as a monitoring area for steelhead spawning and utilization as a "barometer reach" for the upstream watershed.
6) Road obliteration projects should be considered a priority where road densities are high and are in the proximity of riparian areas (Chief Creek, North Fork). Identify roads located in high-risk geology and aggressively pursue closing and draining these road segments.
7) Riparian improvement techniques include planting and culturing (thinning) primary conifer and secondary hardwood vegetation to provide a long term balanced source of large wood and shade. Create micro sites conducive to vegetation establishment. Management in the future should discourage the removal of shade producing vegetation.
8) Reduce accelerated and direct runoff from roads and other managed lands, by removing unused roads by ripping and planting. Special attention regarding stabilization and restoration of vegetation should be given to slides, skid roads, landings, and other areas resistant to revegetation applications.
9) Increased availability and long-term recruitment of large wood, and wood of varying sizes. Large wood could be imported to the stream and/or adjacent side slopes, or cultured through silvicultural practices in Upper East Fork sub-watershed.
10) Improve riparian area vigor and function through increased riparian vegetation and large wood availability, particularly in reaches identified as lacking. Culture riparian vegetation to maximize growth of existing vegetation, encourage conifer growth and occupancy, and provide a short and long-term supply of large and other size wood.
11) Future planning in this basin should recognize the need for protecting riparian conifer vegetation, by selectively releasing existing conifers and by stocking riparian areas with shade tolerant conifers which can produce a large woody debris component and compete with established hardwoods.
12) All culverts limiting fish movement should be assessed and replaced.
13) Maximize the amount of in-stream summer flow by vegetation management (culturing conifer production in hardwood dominated streams). Known priority is the Chief sub-watershed.
14) Return sediment dynamics to a more natural balance by reducing erosion and sediment from roads and recreational trails in the basin.

1.12.2 Terrestrial Module Recommendations

1) Consider a silviculture/fire management plan to incrementally treat high-risk fuel areas with prescribed fire. Consider the use of thinning in LSR allocation areas where the use of innovative long-span skyline systems, helicopter or other aerial means can minimize the supportive road network.
2) Use stand management (regeneration or widely spaced thinning) and prescribed natural fire. Extend the time which seed-sap-pole habitat provides grass, forb, and shrub habitat for 180 associated species (Brown et al. 1985) with manual release and pre-commercial thinning treatments; priority areas are elk winter range (i.e., south aspects with < 40% slope).
3) Past harvest units that are now in late-successional reserves and riparian reserves are heavily overstocked with conifer and hardwood trees. Use silvicultural treatments (thinning) inside managed stands within late-successional reserves, including managed riparian reserves to restore and maintain late-successional conditions.
4) A "deficit" of approximately 30% late successional habitat occurs within the Indigo Watershed (terrestrial 4.7).
5) Approximately 5,400 acres of managed stands (11 percent of the watershed) need treatment to improve habitat for late-successional and riparian reserve dependent species.
6) The restoration activities that would benefit the botanical resources within these watersheds would be those that maintained the diversity of

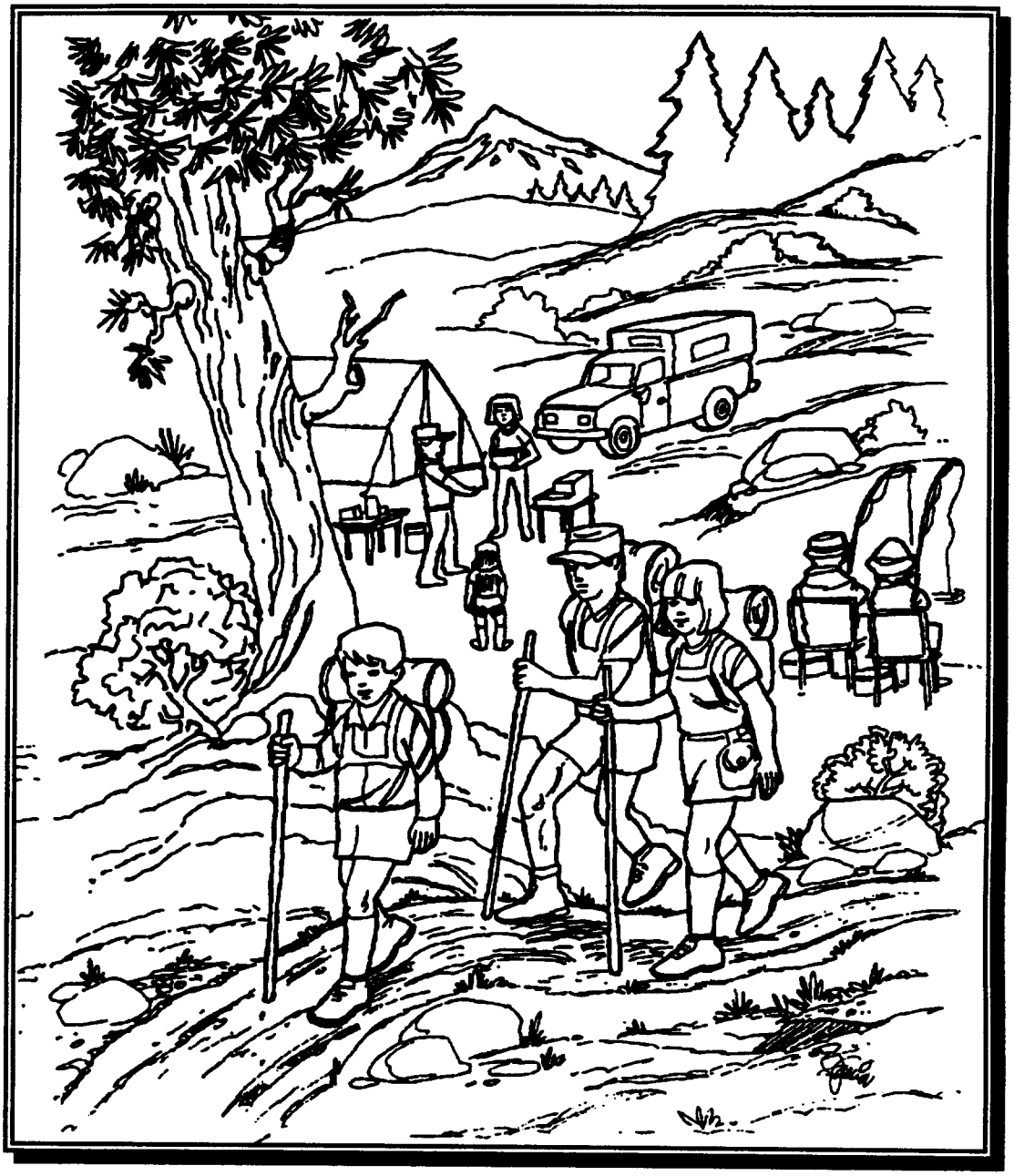
habitat conditions for native species now found there.

7) Identify riparian areas that are at high risk of loss to wildfire and insect activity and consider restoration activities, including thinning, which would decrease risk. A known priority is the Lazy sub-watershed.
6) Recommendations to maintain and restore desired/reference conditions in the watershed, habitat elements are detailed in Appendix A, Table 19.
8) Schedule regeneration harvest activities in Matrix lands through time so early successional habitat will be present through time.

1.12.3 Human Module Recommendations

1) An early priority for analysis is the future transportation needs for Indigo Creek and identify superfluous road segments. Identify roads located in high-risk geology and aggressively pursue closing and draining these road segments. Develop a timetable for road needs for silvicultural purposes and other management activities. Tie this with a timeline for closing roads in East Fork and North Fork Indigo Creek that is measurable and accountable to monitor for implementation success.
2) Analyze the transportation needs for Indigo Creek in the next decade and identify road segments not needed for the minimal management planned in the watershed. Develop a timetable for road needs for silvicultural purposes and other management activities. Develop a timeline for closing roads in East Fork and North Fork Indigo Creek that is measurable and accountable so this effort can be monitoring for implementation success.
3) Future recreational trails should be constructed with crowns or out slopes to maintain sediment sources to a minimum.

INDIGO CREEK WATERSHED ANALYSIS



2.0 HUMAN MODULE

TABLE OF CONTENTS

2.1 INTRODUCTION

Southern Oregon has a long history of human inhabitation. Native American communities have occupied southwest Oregon for at least the last 8,000 years (Aikens 1993). It wasn't until the mid-1800's (and the discovery of gold) that European and Asian populations began to grow in southern Oregon. With that increased settlement came increased fire, land clearing (for agriculture), timber harvest and road building. The rich alluvial soils of the Rogue and Illinois Valleys have experienced a tremendous level of agricultural related development, particularly during the early part of the 20th century. The Indigo Creek watershed has experienced very little of this development, but there is evidence of extensive human use of this watershed primarily focused in the Illinois River/ Indian Flat area. Native Americans prior to widespread settlement used the Illinois River trail by Anglo-American. Early Anglo settlers to the Indigo Creek Watershed included Robert Frantz and Hugo Mayer who settled near the mouth of Indigo Creek. An interesting story about these two characters can be found in the Handbook to the Illinois River Canyon by Quinn, Quinn, and King.

Agriculture, wood products, tourism, and sport and commercial fishing are the province's three basic industries. Recent data indicates that the main area of employment expansion will be in the trades and services industries. Although there has been growth in construction and non-timber related manufacturing, there is still a strong reliance upon the wood products industry for this area's economic well being. The decline in wood products activity through the 1980's was locally amplified by the nation-wide recession. Projections by the State of Oregon Employment Division indicate that the timber industry is expected to lose an additional 1,100 jobs statewide over the next 10 years.

Josephine County has consistently rated among the least wealthy of Oregon counties. Curry and Coos counties have ranked significantly higher in per capita income. Unemployment ranges from 7.2% (Curry) to 8% (Josephine), and the per capita income in 1995 was $15,581 (Josephine), $16,524 (Coos), and $17, 311 (Curry). This ranges from 80.2% to 85% of the State's per capita income. Typically, citizens in this region are older, retired individuals who rely heavily on income from Social Security, retirement, and public assistance programs. The State of Oregon Employment Department reports that in 1995, 26% of all income in Coos and Curry counties was provided by transfer payments, including Social Security, Medicare, other retirement income, veteran's benefits, unemployment and food stamps programs.

71,100 people live in Josephine county, 62,100 in Coos county, and 22,200 in Curry county. Curry and Coos counties population has traditionally shown more dependence upon the timber industry than Josephine. Consistent with throughout the province, communities are diversifying their economic base. The population of Coos/Curry counties fell 2% in the 1980's, the most recent data suggests a turn-around in Curry county since 1990. In 1995, Curry county reported a 14% growth rate, making it one of the fastest growing counties in Oregon. The Brookings - Harbor area grew by 30% in the last decade, making it one of the fastest growing urban centers on the Oregon coast.

The population of Curry, Coos and Josephine County is focused in unincorporated areas. Much of this unincorporated area is identified as the "interface." Throughout the "interface" of forest and rural development there are a number of usually unnamed communities. These communities are defined by little more than a small store or tavern, but play a role in the dissemination of information and the formation of geographic-based community identity.

Over the past decade, a number of demographic shifts have been taking place. Young people who were raised in southern Oregon have been inclined to leave in search of employment while the region has been experiencing a steady increase in overall population. The increase is primarily due to an immigration of both young, professional ex-urbanites and senior citizens (USDI BLM, September 1994).

In all three counties surrounding the Indigo Creek Watershed, the proportion of citizens aged 65 years and older is on the increase. Between 1980 and 1990,

the proportion of persons over 65 in Josephine county increased 42%. In Coos county, the proportion increased 35% and Curry county increased 64% to make persons aged 70 years and older account for nearly 25% of the total population of Curry county.

Seniors are frequently not tied economically to southern Oregon, most receive an annuity of some type. They are commonly here for other reasons including a favorable social climate, proximity to family, and/or enjoyment of southern Oregon's many amenity values. The new, young immigrants generally possess a higher income, higher education level, they generally have strong environmental values but little experience in land management (USDI BLM, September 1994). Few of these folks have ties to the traditional industries of southern Oregon.

Demographics of the Basin and watershed seem to match the Province. A growing population dispersed throughout the "interface" of forest and urban growth. The Applegate Adaptive Management Area's Ecosystem Health Assessment lists a number of social and economic trends occurring in the "interface" which are applicable to this watershed. These include:

- Strong population influx and residential development;
- Dispersed settlement patterns which have created widespread residential/forest interface;
- In-migration of younger, more educated ex-urbanites with strong environmental values and community interest;
- Dramatic shrinking of the local traditional economic bases (specifically, ranching, farming and timber employment;
- Strong representation and economic contribution of "lone eagles," that is "global entrepreneurs" with few ties to the local economy;
- Declining ties to the land for economic contributions and reliance on commuting to urban employment sites;
- Newcomers are less integrated into the community and less knowledgeable about the local ecosystem than in previous decades;
- An increase in a wide-range of recreation activities on public lands, creating endemic conflict between users and challenging management to incorporate these different interests.

2.2 KEY QUESTIONS

2.2.1 What type of local employment has Indigo Creek Watershed contributed in the past, present, and is expected to provide in the future?

Agriculture, wood products, tourism, and sport and commercial fishing are the province's basic industries. Total sales from farms in Jackson and Josephine counties totaled $89.5 million in 1994 and Curry/Coos counties produced $90 million in 1994. (Oregon, 1996). Agriculture including farms, ranches, nurseries, bulbs, grain, hay, vegetables, grapes, and timber-cutting from small woodlots is not as important to the basin as it is to the province. Agricultural related employment in Josephine county averages 500 jobs, with an additional 100 employed during harvest seasons. Coos county generated 500 jobs and Curry county 250 jobs. (Oregon, 1996). There is very little land suitable for agriculture within the watershed.

The province has a continual need for wood products. The first timber extraction appears to have been in the mid-1960's. Between 1965 and 1987, 286.87 MMBF were extracted. This accounts for 5,163 jobs (direct, indirect, and induced jobs, based on formula provided by the Siskiyou National Forest of 18-jobs/MMBF harvest).

Reduced timber output from 1979-1982 had a devastating effect on the state and local economy. During that period, Oregon lost 95,000 jobs (50,000 in the timber industry). By 1986, 68,000 of these jobs had been regained, but nearly two-thirds were in these were in retail trade and service industries (SCORP, 1988) Locally, non-manufacturing jobs increased over 20% led by an increase in trade and services (Oregon, 1993).

Although timber production will continue to provide employment in southern Oregon, the continued survival of communities (especially rural communities) will depend on the region's ability to diversify their economic base. For many rural areas, the path to sustainable economic development will include innovative approaches to natural resource

conservation, management, and utilization (USDA FS, 1993)

Tourism is the third largest industry in Oregon (SCORP, 1988). In 1988, visitors to Jackson and Josephine counties spent $126,235,000 creating 2,826 jobs, while visitors to Coos/Curry counties spent $77,591,000 and created 1,598 jobs (Runyan, 1991). Approximately 73% of all visitors to southern Oregon are from out-of-state. 84% of all visitors participate in some outdoor/nature related activity, 20% of these specifically listed hiking (SOVA, 1991). Regionally, "driving for pleasure" and "sight-seeing" is ranked as the number 1 and 2 (respectively) demanded outdoor recreation activities in 1987 and they are projected to remain 1 and 2 through the year 2040 (USDA FS, 1993). Although few roads exist in the Indigo Creek Watershed, this area is viewed as background from Forest Road 23, a well used recreational route connecting Grants Pass and the Oregon Coast. These statistics indicate that in the region's quest for economic diversification, amenity values such as scenic quality and recreation settings management will play an increasingly important role in the management of the region's natural resources.

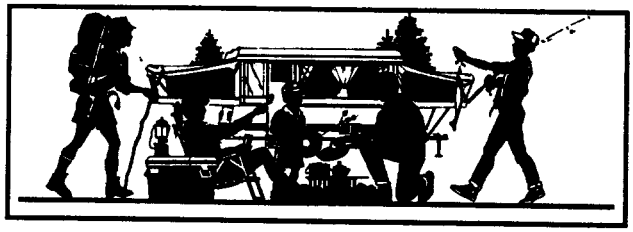
Commercial and sport fishing is economically important to the residents of Coos and Curry counties. They have historically reported major landings of salmon but due to environmental problems impacting fish habitat (including loss of stream-rearing habitat) they have reported that ground fish and shrimp account for 83% of the poundage, salmon accounted for less than 0.5% of the total poundage in 1994. In 1994, 37.9 million pounds of ground fish (including rockfish, sole, and Hake) were grounded. Fishing industry of Coos/Curry counties produced $23,100,000 in 1994.

The Oregon Department of Fish and Wildlife estimates that with an average of 2-3 days of angling effort, a steelhead caught is worth about $150 to the local economy. Surveyor notes from the Indigo Creek stream survey of 1995 report that most evidence of trout fishing was in the lower mile of Indigo Creek associated with the Illinois River trail. Recent changes in State of Oregon fishing regulations require release of all wild trout in the Illinois River and Rogue River; tributaries of the Illinois River, including Indigo Creek, are closed to fishing to protect young steelhead.

Few citizens in the United States see or catch a salmon or steelhead. Opinion polls show that regardless of a citizen's proximity to anadromous fish populations, these fish have a high intrinsic value to most people. People are willing to expend tax dollars, personal income and volunteer labor to conserve salmon and steelhead populations and habitat in the Pacific Northwest. Public interest in the conservation of watersheds, salmon and other fish populations is increasing.

Mining has played a significant role in the early development of southern Oregon. It contributed to the early economy and substantially altered the scenic quality as well as the natural biotic systems.

Mining in the Province began in 1852. The principle minerals were gold, copper and chromium. Today, the primary mining activities in the province are the quarrying of sand and gravel for construction (Oregon, 1996). In 1996, total reported employment from mining was 82 jobs, and these were reported for non-metallic mining (Oregon, 1996). Some employment is known to exist from gold mining, but information on employment and production is difficult or impossible to collect and verify.



Non-timber forest resources (or "special forest products") is a commodity resource which is developing in support of economic diversification. Special forest products include; aromatics, berries, chips, shavings, excelsior, sawdust, bark, smokewood, fuelwood, decorative wood, forest botanicals, greenery and floral products, honey, mushrooms, and wildlife. Except for the collection fuelwood (which appears to be tied to timber harvest activities), conversations with land managers in the province confirm that sale of these products have

been on the increase. Due to inaccessibility, most of the Indigo Creek Watershed is unsuited for this form of development.

2.2.2 How Does the Indigo Creek Watershed Provide For Amenity Values? Is There A Difference Between Past, Present, And Future Values?

Amenity values relate to visitor satisfaction. These are subjective and personal values that vary from individual to individual. Generally, examining such items as the scenic quality, wilderness values (or how well the watershed provides for an individual's need for solitude), and what settings are available within the watershed for recreational activities to take place can predict satisfaction.

2.2.3 What Is the Past, Present, And Future Recreation Use Of The Watershed?

An overview of the recreation settings in the Indigo Creek Watershed is provided under Question 2 above. In addition to that information, Siskiyou National Forest has the following trails and facilities;

Facilities:

Bear Camp Pasture;

Trails: (total 22.5 miles)

Fish Hook Peak Trail #1180
Approx. 2.5 miles.

Silver Peak - Hobson Horn Trail (#1166)
Approx. 13 miles in the Indigo Creek Watershed.

Illinois River Trail (#1161)
Approx. 2 miles in Indigo Creek Watershed.

There are 2 commercial river guides with permits to guide on the Illinois River. Non-commercial use of the Illinois River was reported as 485 river users in 1996. Two commercial guides are permitted to guide in the Indigo Creek Watershed, using the Silver Peak-Hobson Horn Trail (#1166) and the Illinois River Trail (#1161). The Illinois River Trail received 1,500 users in 1996, and the Silver Peak-Hobson Horn Trail has received approximately 150 users in 1996. The trail received little use since 1992 when storms dropped hundreds of trees across the trail in the vicinity of the Silver Fire burn. There are a number of fishing guide services listed in the local phone directories who gain some benefit from Indigo Creek Watershed (based upon rearing habitat provided within the watershed).

In 1993, the Siskiyou National Forest reported that the Bear Camp Road (Forest Road 23) on the north edge of the watershed has an average daily traffic (ADT) of 136 vehicles. 107 of these were recreation oriented. The Burnt Ridge Road (Forest Road 2308) had an ADT of 13. 12 of those were recreation oriented. These numbers vary annually based upon timber harvest, road, and weather conditions, but the numbers have been steadily increasing.

Trends and demand projections indicate that recreation use will continue to grow in the Indigo Creek Watershed. It provides an experience similar to wilderness without the restrictions of wilderness, making it suitable for users of all types. The degree of isolation and solitude that this watershed provides makes it an extremely valuable and unique recreation resource to the province as well as the Siskiyou National Forest.

The watershed's only trail connections are the Silver Peak - Hobson Horn Trail, which follows the ridgeline divide between Silver Creek and Indigo Creek. Future connections could be made (by restoring some of the historical trails) to make non-wilderness trail connections east-west across the Galice District to the Gold Beach Ranger District's trail system. Opportunities to build connections between trails should be sought especially where historic trails may still be usable.

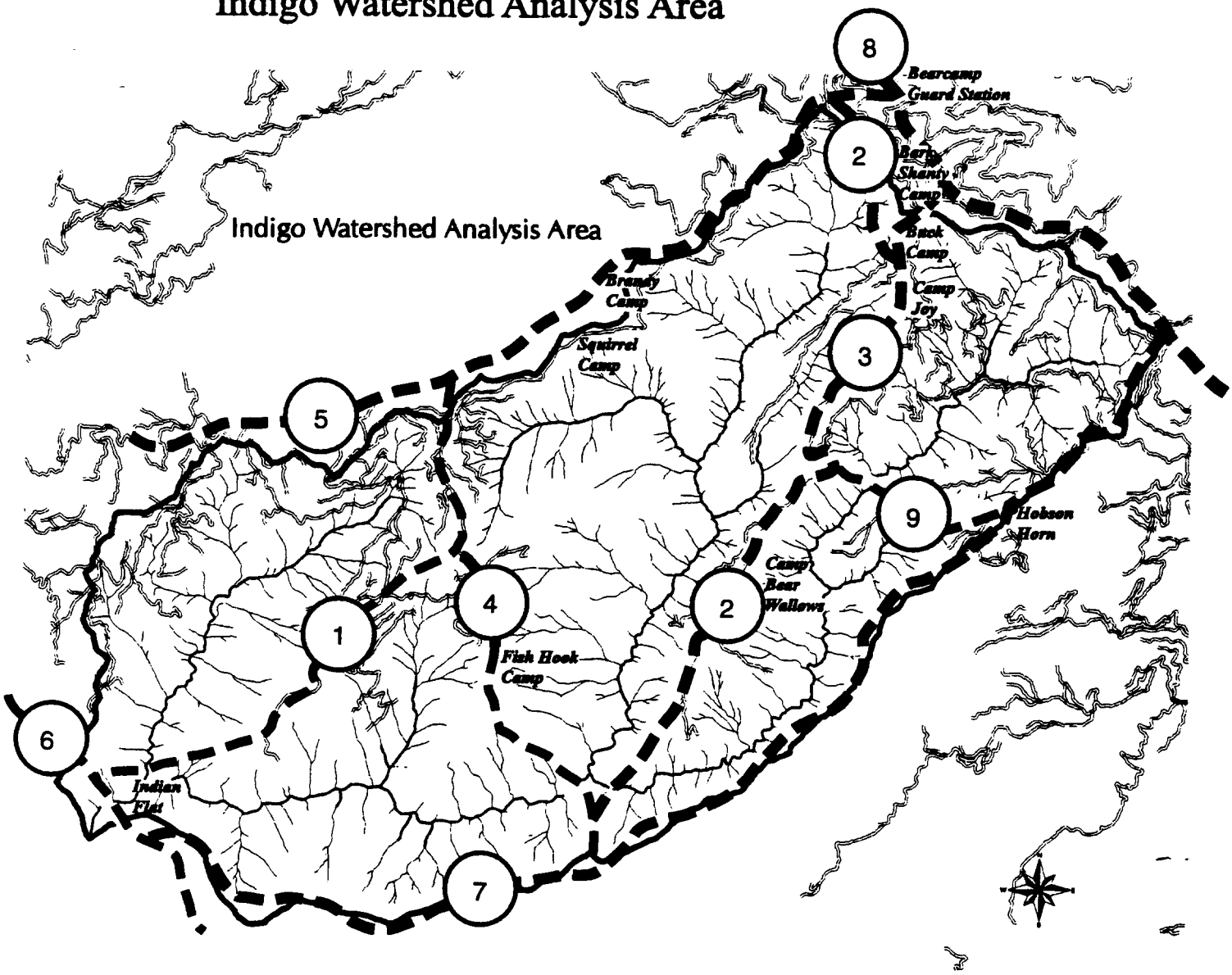
2.2.4 Trails and historic trail access.

The 1937 forest map shows a number of trails which crossed the Indigo Creek watershed (mostly) in a westerly direction from the Silver Peak - Hobson Horn trail.

Illinois River Trail:
Connection from Illinois River Road (Josephine County) to Oak Flat Road (Agness)

Indigo Prairie Way:
Connection from Illinois River Trail (at Indian Flat) to the Bear Camp Ridge Trail, then on to Fish Hook Peak and Silver Peak - Hobson Horn Trail.

Historical Trails Through the Indigo Watershed Analysis Area



Trail Key

1= Indigo Prairie Way
2= Lazy Creek Way
3= Lazy Creek Trail
4= Trail to Fish Hook Peak*
5= Bearcamp Ridge Trail
6= Illinois River Trail
7= Silver Peak - Hobson Horn Trail
8= Bob's Garden Mountain Trail
9= Unidentified trail is referred to in 1937 trail log.

NOT TO SCALE
All trail locations are approximate
Based on records from 1937
* Shown on Map or indicated in trail log

Silver Peak - Hobson Horn Trail:
Connection from the Illinois River Trail at the Indigo Creek/Silver Creek divide to the Bear Camp Trail at Sourgrass Camp

Lazy Creek Way
Connection between the Bear Camp Ridge Trail (near Squirrel Camp) and the Silver Peak - Hobson Horn Trail.

Lazy Creek Trail
Connection between Buck Camp and the Lazy Creek Way

In addition to the above trails, the current Siskiyou National Forest Map shows:

Hardscrabble Trail #1165 that was deleted from the Siskiyou National Forest Trail system in 1983. It formed a connection between the Illinois River Trail and Indigo Prairie.

Several helispots (remote helicopter landing locations) are located within the Indigo Creek drainage. These provide access to areas inaccessible by vehicular traffic. Helispots considerably reduce access time during wildfire and human rescue emergencies.

2.3 ASSESSING VISUAL QUALITY

Visitors participating in recreational activities are generally more sensitive to highly modified landscapes. For that reason, USDA Forest Service manages for scenic quality in highly used recreational areas. The Siskiyou National Forest outlines management of the Siskiyou National Forest Visual Resources in their Land Resource and Management Plan (LRMP) by assigning Visual Quality Objectives (VQO's) to the landscape. Criteria used to define VQO's are: scenery quality ratings, public sensitivity ratings, and distance from the viewer. The Siskiyou National Forest LRMP described management objectives by VQO as follows;

MA 12: Retention Visual: This land is managed with the primary goal being "to provide a level of attractive scenery by maintaining the area in a natural or near natural condition." "Management activities will be conducted in such a way that they are completely subordinate to the character of the landscape and not evident to the casual Forest visitor."

MA 13: Partial Retention Visual: This land is managed with the primary goal being "to provide a level of attractive scenery by maintaining the area in a near natural condition." "Management activities will be conducted in such a way that they are subordinate to the character of the landscape."

MA 14: General Forest (VQO: "Modification"): Land managed with the primary goal being "to obtain a full yield of timber within the capabilities of the land..." The VQO for this management area is modification.

Assessing visual quality is a two step process. Standardized, objective size and area criteria have been established as a general "rule of thumb." Site specific analysis is more subjective. Using objective criteria outlined in USDA Forest Service Manual 2380 Landscape Management, Agriculture Handbook #462, each sub-basin was assessed as generally meeting or generally not meeting the stated VQO.

The Indigo Creek Watershed is primarily designated in the Siskiyou National Forest LRMP as MA-14 (General Forest) with a stated visual quality objective of modification. 10,562 acres is designated as MA-13 (Partial Retention) and 1,293 acres as MA-12 (Retention).

Partial retention lands are mostly concentrated in the northeast portion of the watershed, while Retention lands are located in the Illinois River corridor.

The watershed has a number of scattered units, particularly visible from the Burnt Ridge Road (FS Road 2308). These units with their odd shapes and large-scale, do not meet the Siskiyou LRMP standard and guideline regarding the modification visual quality objective (MA 14-1). This will change over time, as the replanted harvest units grow to reduce the visual texture changes present in the landscape.

Generally, the landscape meets the visual quality objectives in the land managed as MA 13 (Partial Retention) and MA 12 (Retention). The primary viewpoints are located along the Bear Camp Road

(FS road #23) for the MA 13 lands and along the Illinois River for the MA 12 lands.

In addition, the USDA Forest Service uses the "Recreation Opportunity Spectrum" (ROS) as a method to classify land as to its suitability as a setting for recreation activities.

Settings within the watershed are classified as "Roaded Natural" (RN), "Semi-primitive Motorized" (SPM), and "Semi-primitive, Non-motorized" (SPNM). RN lands are generally located within 1/4 mile of existing roads, SPNM lands are located in the interior of the watershed with SPM settings located along the route of the Silver Peak - Hobson Horn trail.

Many of the interior regions of the Indigo Creek Watershed area possess values normally associated with wilderness. Most of this watershed has a complete "Roadless Area evaluation" contained in APPENDIX C of the Siskiyou National Forest Land and Resource Management Plan FEIS. It is identified as #6176, the North Kalmiopsis. A full discussion of this area's wilderness characteristics can be found in that document. In summary, this area was found to have HIGH natural integrity, MODERATE opportunities for solitude, HIGH opportunity for primitive experience, and HIGH public interest.

Most of this watershed has remained in what appears to be a state unaltered by man. Timber harvest has been concentrated around the perimeter and along existing roads, leaving the interior of the watershed in an unaltered condition, though several Silver Fire harvest units are more than one mile from roading. The interior remains largely unroaded. Human access is by paths of their own making into the steep river canyon or by using the game trails which criss-cross the steep hillsides. This area appears very much as it did a century ago. Users today, as in the past, need to be experienced, physically fit and very self-reliant. Trails (and river travel) provide the primary access to the lower sub-basin.

In the past, our society has sought to enter and develop unroaded areas like the interior of the Indigo Creek watershed, and this pressure for economic development still persists. Recently, public sentiment is leaning a little more toward the value of unroaded areas for recreation, wildlife, and ecosystem health. The demand for non-wilderness, roadless areas like the Indigo Creek Watershed have been increasing. It is projected that demand will exceed capacity for this type of recreational setting by the year 2000. The Indigo Creek watershed is part of the North Kalmiopsis Roadless area that drew public support in the 1970's and 80's for designation as wilderness.

The Indigo Creek Watershed provides some extraordinary scenic quality, clean water and unique recreation settings for most visitors.

2.4 TRANSPORTATION SYSTEM

The Transportation system in this watershed is served by two public road systems. These systems include the Merlin-Galice Road and the Curry County Road (Jerrys Flat Road).

The Merlin-Galice road provides access from the east to BLM road 34-08-36 then to Forest Service road 23. Curry County road #595 provides access from the west to Forest Service road 2308, part of which, is the northern boundary of the Indigo Watershed. In the early part of this century access into this watershed was by trail. In the early 30's the first roads started to appear and were used to remove timber. The majority of roads in this watershed were constructed in the 70's and 80's. The trails that remain today are being used for recreation. In the early 90's the Bear Camp road 23 and BLM road 34-08-36 were designated a Back Country Bi-Way.

Within the watershed there are approximately 111 miles of existing road today. This is 4% of the total forest road system and 13% of the total Galice Ranger District system and 6% of the total Gold Ranger Beach District system. These roads are listed by maintenance level as follows:

Maintenance Level 4 and 3 roads are maintained for comfortable travel by passenger cars, while Level 2 roads are maintained for high clearance vehicles such as pickup trucks and four wheel drives. Maintenance Level 1 roads are closed, but still shown on the Transportation management system. Level 4 roads are maintained on a yearly basis. Level 2 roads are

maintained for resource protection or, when they need upgrading.

TABLE 2.1
GALICE RANGER DISTRICT

Maintenance Level	Miles Of Road	Right Of Way Acres	Surface Type
4	7.90	32.75	Asphalt
2	55.82	227.34	Aggregate & Native
1	11.35	33.00	Native

TABLE 2.2
GOLD BEACH RANGER DISTRICT

Maintenance Level	Miles Of Road	Right Of Way Acres	Surface Type
2	33.19	135.17	Aggregate & Native
1	2.74	7.94	Native

In the early 90's a Hazard Analysis was conducted on the Bear Camp road and the portion in the Indigo Watershed had no safety issues identified. Bear Camp road is maintained yearly but is closed due to snow for 2 to 3 months every year. The remaining roads in this watershed are maintained on a rotational basis when funding is available. Level 2 roads are scheduled for maintenance on 3 to 4 year cycle, and level 1 roads on a 5-year cycle. There are some areas susceptible to damage during heavy periods of rain. Those roads and problems are listed below:

In 1994, a Transportation Network Analysis was completed forest wide to determine the future needs of the transportation system. Historically, timber management was an important emphasis on the forest and the primary reason an extensive road system was developed. The forest envisions a less extensive road system and possibly an expansion of the trail network. This road system will allow reasonable access to major points of interest, areas of resource management and travel across the forest. Indigo Watershed contained roads that were identified as candidates for closure, obliteration, or conversion to another use. A list of those candidate roads is available at the Eastside Engineering Zone.

TABLE 2.3
INDIGO WATERSHED ROAD REPAIR/MAINTENANCE NEEDS

Road Number	Township & Range	Section	Description
2300052	T. 34 S., R 9 W.	32, 33	Culverts plug & cut bank failure.
2300055	T. 34 S., R 10 W.	11	Culvert Plugging
2300415	T. 34 S., R 9 W.	29	Slides
2300416	T. 34 S., R 9 W.	20, 29	Slides
2308071	T. 34 S., R 10 W. T. 35 S., R 10 W.	31 5 & 6	Road slips & culvert plugging

HUMAN REFERENCES

Aikens, C. M., 1993.
Archaelogy of Oregon. Bureau of Land Management. Portland, OR

Diller, 1914
Diller, J. S. and Kay, G. F., Mineral Resources of the Grants Pass Quadrangle and Bordering Districts, OREGON: Contributions to Economic Geology, 1908. USDI USGS Bulletin #380, 1914

Files
Miscellaneous historical documents contained in the 2800 Minerals Administration files. Siskiyou National Forest, Galice Ranger District, Grants Pass, OR.

Oregon, 1992
Oregon Covered Employment and Payrolls by Industry and County. State of Oregon, Employment Department; Research, Tax, and Analysis, 1992

Oregon, 1993
Regional Economic Profile, Region 8. State of Oregon, Employment Department

Runyan, 1988
The Economic Impacts of Travel in Oregon, 1988. Dean Runyan Associates, Portland, OR.. Prepared for the State of Oregon, Oregon Economic Development Department, Tourism Division

SCORP, 1988
Oregon Outdoor Recreation Plan 1988-1993. State of Oregon, Oregon State Parks and Recreation Division, Planning and Grants Section

SOVA, 1991
Profile of Summer Visitors to Southwestern Oregon. By Rebecca L. Reid, Southern Oregon Regional Services Institute, Southern Oregon State College, Ashland, OR. for the South Western Oregon Visitors Association, August, 1991

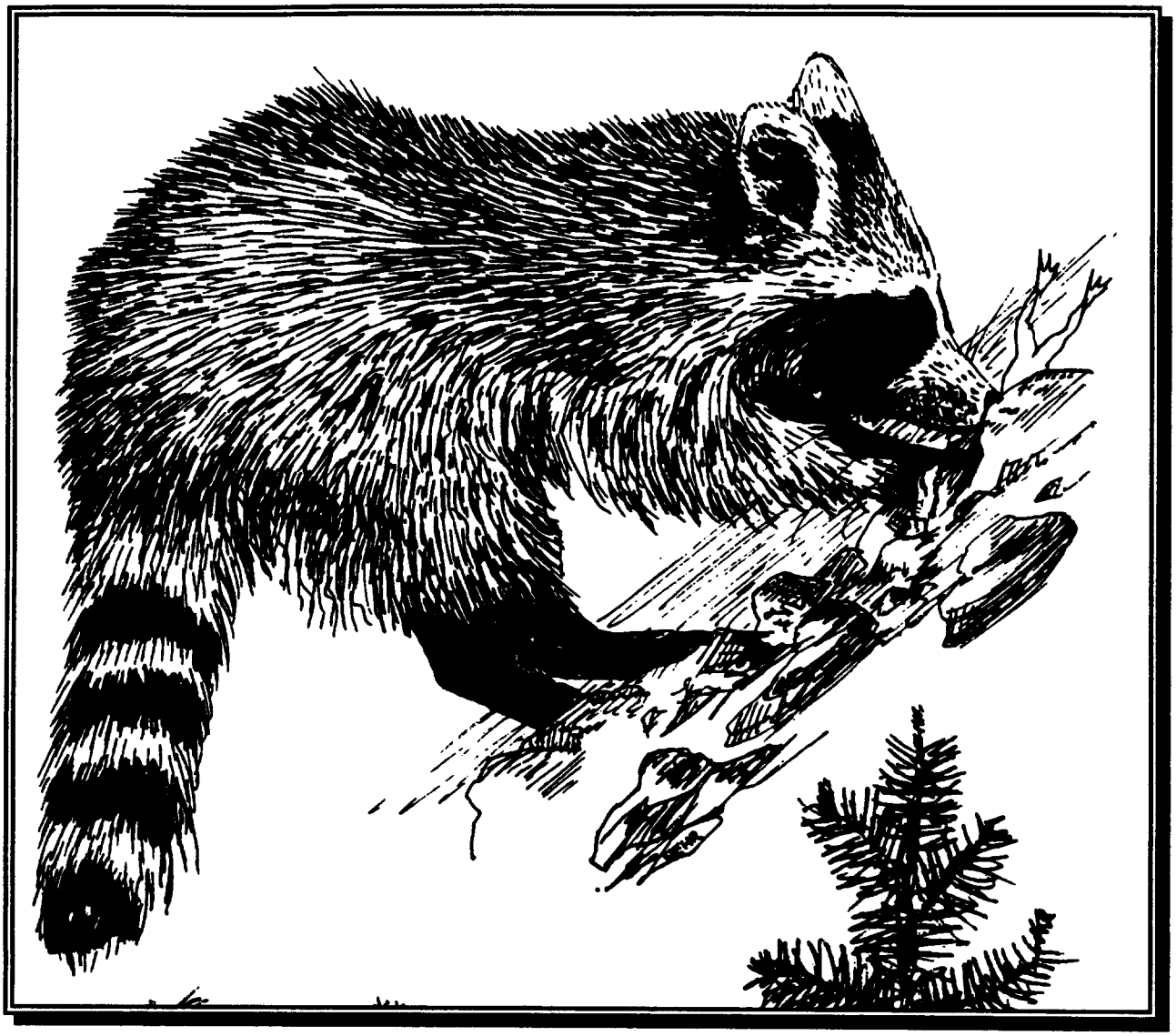
USDA FS, 1993
Income Opportunities in Special Forest Products, Self-Help Suggestions for Rural Entrepreneurs. USDA Forest Service, Agriculture Bulletin #666, May 1993

USDI BLM, May 1994
Issues and Alternatives for the Management of the Hellgate Recreation Area of the Rogue River. USDI Bureau of Land Management, Medford District May 1994

USDI BLM, September 1994
Applegate Adaptive Management Area, Ecosysytem Health Assessment. USDI Bureau of Land Management, Medford District, USDA Forest Service, Siskiyou, Rogue River National Forests and PNW Research Station.

USDI BLM, October 1994
Medford District Proposed Resource Management Plan/ Environmental Impact Statement. USDI Bureau of Land Management, Medford District, October 1994.

INDIGO CREEK WATERSHED ANALYSIS



3.0 TERRESTRIAL MODULE

TABLE OF CONTENTS

3.1 VEGETATIVE CHARACTERISTICS AND SETTING

The Indigo Watershed contains a diverse assortment of plant communities. Refer to Table 3.1 for a acreage and percentage distribution of plant series in the watershed. Aspect, elevation, slope, parent material, soil depth, climate, fire history, past management activities, and a variety of hydrologic regimes combine to produce the following habitats for plant communities:

- coniferous forest
- hardwood forest
- mixed conifer/broadleaf hardwood forest
- rock outcrops, ridges, and screes
- brush fields
- riparian areas
- wet meadows, seeps, and bogs
- dry meadows and grassy areas
- open woodland (conifer, hardwood, mixed)

Rock outcrops, talus, and rocky ridges are common, particularly along Burnt Ridge. Sensitive plant species that include this habitat include *Arctostaphylos hispidula* (Howell's manzanita) and *Fritillaria glauca* (Siskiyou fritillaria).

Wet meadows, seeps and bogs are present in limited amounts in the upper reaches of drainages, particularly below Bear Camp Ridge. Sensitive plants species that are present or may be found in this habitat include *Bensoniella oregana* (Bensonia).

TABLE 3.1
PLANT SERIES DISTRIBUTION

Plant Series	Acreage	Percentage
Douglas-fir	10,618	21.7%
White fir	8,655	17.7%
Tanoak	8,179	16.8%
Douglas-fir tanoak	21,348	43.8%

Higher elevation coniferous forests are most often dominated by the white fir plant series. These forest stands consist of true fir species such as white fir and Shasta red fir, Douglas-fir, and sugar pine and chinquapin as common associate species.

Mid-to-lower elevation coniferous, hardwood, and mixed conifer/hardwood forests predominantly include the Douglas-fir, tanoak, and Douglas-fir/tanoak series. Species composition of these stands is often very diverse, ranging from near-pure stands of Douglas-fir, mixed conifer types, pure hardwood stands (usually combinations of madrone, tanoak, canyon live oak, and chinkapin), and various mixed conifer/hardwood types. Areas with a history of recurrent high-intensity wildfire are often dominated by knobcone pine.

Riparian habitat is present at all but the highest elevations. Sensitive plant species preferring riparian habitat within the Indigo Watershed include *Iliamna latibracteata* (California globemallow).

Dry meadows, grassy areas, and brush fields are interspersed throughout the area in pockets ranging from a fraction of an acre to over 100 acres. Sensitive plants found in these areas include *Frasera umpquaensis* (Umpqua green-gentian) and *Triteleia hendersonii leachiae* (Leach's Brodiaea).

3.1.1 Seral Stages

The vegetative cover of the Indigo Watershed features considerable diversity in terms of plant communities and seral stages. Of the major seral stage groupings that occur within the watershed, 28% are occupied by late-seral forest stands. This stage includes mature and old-growth conditions, ranging from the point where tree growth slows (typically after age 100) through development of increased stand structure. During the latter phase, stands retain fewer large overstory trees per acre, develop intermediate shade-tolerant canopy levels and canopy gaps, and increase the recruitment of snags and down wood.

Approximately 18% of these lands are occupied by mid-seral forest stands, which typically occur from ages 40 through 120 and feature stand diameters of 12 inches or greater. During this time, competition-related mortality of understory trees accelerates while dominant trees continue to make significant growth.

Approximately 27% of lands are occupied by early seral vegetation, including pioneer and early seral.

Plant communities change rapidly during this period, with forest development progressing from seedling-shrub through pole-sized trees. Most of the watershed's managed stands are categorized as early seral, with the exception of areas affected by recent intense wildfire and recent timber harvest. Unmanaged early seral stage communities include dense coniferous pole stands, often with larger older trees interspersed at a wide spacing, indicating a history of frequent fire.

Approximately 23% of lands are occupied by pioneer seral vegetation. This period begins after some type of disturbance and subsequent development of pioneer herbaceous and sprouting shrub vegetation, through the time when stands are dominated by larger shrubs and small conifer seedlings. The 1987 Silver Fire affecting 43% of the Indigo Watershed included approximately 15% of stand acres that burned at high intensity, where nearly all above-ground vegetation was consumed. In addition, other stands that burned at a moderate intensity have inclusions of stand-replacement burn intensity that are also categorized as pioneer vegetation, although much of the initial stand structure was maintained. Vegetative recovery has been rapid on most intensely burned sites, with aggressively sprouting brush accounting for most of the vegetative cover. Knobcone pine has successfully invaded those sites where fire enabled serotinous cones to release seed. Post-burn reforestation of suitable sites and subsequent vegetation management has provided early seral conifers with an early competitive advantage.

Approximately 4% of lands within the Indigo watershed are not capable of developing continuous forest cover and consequently do not exhibit a great deal of vegetative change over time. Surface rock, extremely skeletal soils, low shrubs, and very sparse tree cover are characteristic of such non-forest lands.

Periodic fluctuations in the magnitude of disturbance events have contributed to the variation in seral stage distribution between the watershed's sub-basins. Both human-caused and other disturbance agents (such as fire, wind, and insects) have played a role.

Table 3.2 displays Pacific Meridian (PMR) satellite imaging data, with area in acres and percent acreage by sub-drainage for each of the major seral stage classes within the Indigo Watershed:

3.1.2 Plant Series

Forest stands have been grouped into "plant series", aggregations of plant communities that indicate site conditions such as soil type, site productivity, regeneration potential and fire frequency. Each series is identified by the potential climax species that would predominate after an extended disturbance-free period. Four plant series and plant series groupings have been identified within the watershed: white fir, Douglas-fir, tanoak, and Douglas-fir/tanoak.

The Douglas-fir series occurs in areas where evapo-transpirational demand is high and tends toward warmer aspects and higher slope positions. It occurs under conditions that favor fire wherever it occurs (Atzet and Wheeler, 1982).

The tanoak series tends to occur on moister more productive sites with lower evapo-transpirational stresses and less-frequent fire intervals. Tanoak reflects more available moisture than its associated hardwoods and is replaced by Pacific madrone, canyon live oak, California black oak, and Oregon white oak on warmer, drier aspects (Agricultural Handbook 654). This species is also sensitive to cold temperatures at higher elevations and is replaced by other hardwood species. Sometimes the Douglas-fir and tanoak series occur in a coarse mosaic, with subtle shifts in microsite and soil conditions affecting species composition and regeneration potential. This blend of communities is referred to as the Douglas-fir/tanoak series.

The white fir series is generally encountered at elevations above 3,000 feet and some moist sites lower in elevation. White fir encroachment is occurring within other series.

TABLE 3.2
SERAL STAGE DISTRIBUTION
BY SUB-DRAINAGE
(Based on PMR Data)

Sub-Watershed	Seral Stage	%	Acres
Brandy	Pioneer	21	194
	Early Seral	44	397
	Mid Seral	17	150
	Late-Seral	17	157
	Non-Forest	1	5
Breezy	Pioneer	24	376
	Early Seral	20	314
	Mid Seral	14	219
	Late-Seral	37	575
	Non-Forest	4	61
Chief	Pioneer	22	391
	Early Seral	30	522
	Mid Seral	17	303
	Late-Seral	28	486
	Non-Forest	3	59
East Fork	Pioneer	34	2706
	Early Seral	22	1757
	Mid Seral	13	1035
	Late-Seral	21	1669
	Non-Forest	10	810
Indigo	Pioneer	22	2351
	Early Seral	23	2482
	Mid Seral	21	2255
	Late-Seral	27	2898
	Non-Forest	7	800
Lazy	Pioneer	20	336
	Early Seral	22	366
	Mid Seral	16	261
	Late-Seral	40	655
	Non-Forest	2	33
North Fork	Pioneer	21	1748
	Early Seral	23	1971
	Mid Seral	22	1842
	Late-Seral	32	2728
	Non-Forest	2	202
Slim	Pioneer	31	235
	Early Seral	45	343
	Mid Seral	13	99
	Late-Seral	10	77
	Non-Forest	1	3
Snail	Pioneer	20	751
	Early Seral	31	1167
	Mid Seral	16	609
	Late-Seral	28	1042
	Non-Forest	4	151
Upper East	Pioneer	21	435
	Early Seral	28	572
	Mid Seral	17	348
	Late-Seral	32	640
	Non-Forest	2	30
Upper West Fork	Pioneer	14	442
	Early Seral	42	1378
	Mid Seral	17	548
	Late-Seral	26	844
	Non-Forest	1	19
TOTAL	Pioneer	23	11261
	Early Seral	26	12842
	Mid Seral	18	8703
	Late-Seral	28	13490
	Non-Forest	5	2730

Comparison of seral stage distribution within the most common plant series in the Indigo Creek watershed indicates that the tanoak series hosts a comparatively high percentage of late seral stand conditions. Topographic conditions such as aspect and slope position, and atmospheric moisture conditions on these sites tend to favor less frequent but more intense fire events than typically occur for the other plant series present, allowing for development of large conifer characteristics within the more productive stands. Lands within the Douglas-fir series comprise the highest percentage of area within pioneer and early seral stages, attributable to recent fire events.

3.1.3 Tree and Shrub Species

Douglas-fir is the most common overstory tree found in the Indigo Watershed and is frequently associated with other conifers, including sugar pine, knobcone pine, white fir, Shasta red fir, incense-cedar, western hemlock, Port-Orford-cedar, and Pacific yew. Associated hardwoods include Pacific madrone, tanoak, golden chinquapin, bigleaf maple, red alder, canyon live oak, Oregon white oak, and California black oak.

Stand structure is quite variable and ranges from single-storied and even-aged to multi-aged and structurally complex. Two to four age classes is typical of most stands, although one or two cohorts tend to predominate. This condition generally relates to past fires and other disturbances that have taken place over time. Less-productive sites that lack continuous crown cover are often more structurally diverse than productive sites that feature a strong dominant/codominant size class.

Common shrub species include tanoak, Sadler oak, canyon live oak, poison-oak and several species of manzanita and Ceanothus. Species such as Pacific

rhodōdendron, salal and sword fern are found most often on cooler sites and within riparian zones.

3.1.4 Vegetation Conditions and Trends

The current vegetation pattern within the Indigo watershed developed as a result of geologic and climatic conditions, floristic migration over time, and periodic disturbance, both natural and human-caused. Fire is the most evident disturbance agent in the watershed. Past fire occurrence prior to European settlement is attributed to a combination of lightning strikes and Native American burning. After 1850 the incidence of Native American burning declined, but miners, ranchers, and other settlers set frequent and extensive fires. The 1987 Silver Fire Complex was lightning-caused and burned the southern-most 20,000 acres in the Indigo Watershed, over 40% of the watershed area.

For an approximate 70-year period prior to 1987, active fire suppression had effectively excluded fire from much of the area (Atzet and Wheeler, 1982). Fire suppression efforts over the years increased the availability of fuels, which in turn affected the Silver Fire's behavior and its effects on vegetation (Silver Fire Recovery Project FEIS, 1988).

Watershed stand data suggests that earlier frequent fire intervals contributed to existing within-stand species and structural diversity, where several age and size classes are present. Similarly, the 1987 fire created a complex mosaic of light underburns, stand gaps and larger-patch burned over areas, providing conditions favorable for the establishment of pioneer vegetation, and also favoring residual vegetation in many instances. When natural disturbances are allowed to proceed, surviving trees expand into available growing space, which is also invaded by a new age class of trees that compete amongst themselves and with older individuals (Oliver and Larson, 1990).

Data was analyzed to estimate pre-fire-suppression fire periodicity within the watershed, as evidenced by distinct age groupings that related to past disturbance events. Using this method, the average fire return interval was determined to be approximately 44 years. It is noted that this estimate is likely too infrequent, since the disturbance effects of low-intensity fire do not generally include significant changes in stand structure or composition (McCrimmon, 1995). Atzet and Martin (1991) determined mean fire interval for the Douglas-fir, tanoak, and white fir plant series in the Klamath Region to be 30, 25, and 90 years respectively. These intervals are likely to be more indicative of past events in the Indigo Watershed than stand data would indicate.

Most historic fire-related disturbances within the Indigo Watershed appear to have been of low to moderate intensity, with a sizable proportion of trees in the larger size classes surviving the fires. High intensity or "stand replacement" fires where most vegetation is consumed have been less frequent, although there is considerable evidence of repeated higher-intensity intense wildfire having occurred in the Burnt Ridge/Brandy Peak portion of the watershed, and continuing further west into the Shasta Costa watershed. Most of the historic panoramic and still photographic evidence from the Indigo and adjacent watersheds show a pattern of mountain meadow/brushfield complexes on higher ridgelines and south slopes, with concentrations of mature conifer cover typically occurring on cooler aspects and lower slopes. Stand data indicates that high intensity fires affecting established stands ranged at intervals of approximately 100 to 250 years and occasionally higher. Some existing stands comprise a high proportion of dominant trees older than 300 years.

In order to assess trends associated with vegetative conditions in the Indigo Watershed, a point of reference needs to be established that can be contrasted with existing conditions. For the sake of this analysis, a reference point dating back 50 years from the present (1947) has been established. At that time, widespread road construction and intensive timber management had not yet been initiated within the watershed. Fire suppression in 1947 was still in an initial stage, having been initiated around the mid-1920's. Consequently, the long-term effects of aggressive fire suppression were not yet evident.

The effects of fire exclusion on forest lands of the watershed can be weighed against the effects of past management practices to determine an approximate degree of departure from historic vegetative patterns. By using a combination of satellite imagery capable of classifying vegetative cover

types, managed stand data, and backtracking existing vegetative conditions to a specified point in time, - the combined effects of natural and management-induced trends taking place during the past 50 years can be displayed. The following conditions and events have been notable in affecting changes in vegetative pattern and seral stage distribution:

1. Fire suppression, the effect of which has been a departure from frequent, low-impact fires to less-frequent higher-impact fires. A lack of large-scale fire disturbance (prior to 1987) allowed forest stands to develop toward later seral stage characteristics.
2. Timber harvest, shifting affected areas from typically late to pioneer stage vegetation, creating a different vegetative pattern from historic.
3. Wildfires, the recent nature and extent of which departs somewhat from the historic picture, where fire was relatively frequent but occurred at close intervals, most often between 20 and 50 years. Most burned areas within the Indigo Watershed had not experienced fire for 70 years or more.

Using existing seral stage data, it is possible to project back through time and estimate what conditions might have occurred within the watershed prior to fire suppression and timber harvest. Using the 1947 reference point, the following assumptions were made:

1. Managed stands that were regeneration-harvested and are currently in pioneer through early-seral stages were 80% late seral and 20% mid-seral 50 years ago. Intensely burned stands that were artificially reforested following the 1987 Silver Complex fire are categorized as managed stands.
2. Unmanaged stands currently in pioneer and early seral stages located on lands capable of developing forest cover were 45% late, 15% mid, and 40% early seral stage 50 years ago (Southwest Oregon Ecosystem Assessment Team, Atzet et al, 1993).
3. Existing mid-seral vegetation was 67% early seral and 33% mid-seral 50 years ago.
4. Existing late-seral vegetation was 75% late seral and 25% mid-seral 50 years ago.

The results of this trend analysis are compared with existing conditions in Figure 3.1.

A notable difference between estimated 1947 and current conditions is the increase in the proportion of forest lands in pioneer/early seral stage and considerable decrease in proportion of late seral forest. A combination of management and recent natural disturbance events are responsible for this shift. Mid-seral forest land acres show only a slight change in total acreage, although its presence has for the most part shifted to other locations within the watershed. Prior to the 1987 fires, mid-seral acreage was considerably higher, possibly as high as 30% overall. However, in affecting 40% of the Indigo watershed, the fires moderated the effects of long-term fire suppression and reduced the acres of mid-seral lands to a level that is somewhat closer to historic conditions.

It is also possible to project vegetative growth forward, as a basis for predicting what seral stage distribution might exist if no further high-intensity disturbance took place. The assumptions for this condition are that fire suppression efforts would be 100% effective, damaging insect populations would remain within typical endemic levels and that stand regeneration harvest would not occur. In projecting stand development forward 50 years, areas with pioneer or early seral stage conditions become mid-seral, most existing mid-seral vegetation becomes late-seral, and late seral vegetation remains as such. Areas classified as non-forest land (permanent grassland or shrub-type, rock, water, etc.) are not changed from their current condition.

It should be noted that this projection is largely hypothetical and does not consider associated risks such as insect attack, increased risk of catastrophic fire as a result of increased fuel loading and "fuel ladders", and the effects of periodic drought on overstocked stands.

If fire suppression proved successful for a long extended period, stand structural changes such as dense understudy development, increased occupancy of shade-tolerant trees and shrubs, and increased development of fuel ladders would

become the predominant condition in most stands. Average patch size would increase as existing age and size class distinctions between adjacent stands became less distinct. The increased fuel loading associated with extended fire suppression would tend to contribute to less frequent but more intense fires. Species types maintained by frequent fire regimes, such as large pines, would likely decline in the absence of disturbance that reduces stand density.

FIGURE 3.1
SERAL STAGE TREND ANALYSIS

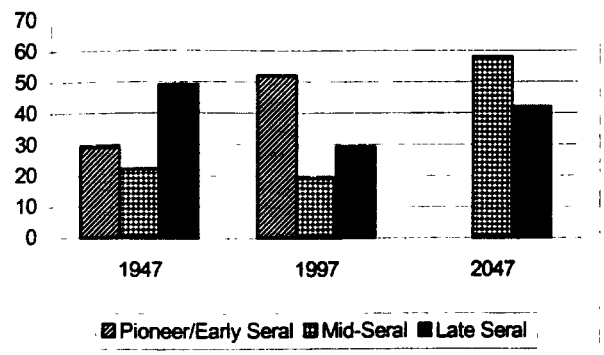


Figure 3.1 displays 1947, current and projected seral stage distribution in 50 years.

3.1.5 DENSITY OF VEGETATION

For stands having little or no recent disturbance, density of mid- and late-seral stands expressed in square feet of basal area generally ranges from 120 to 400 per acre. Plot density in excess of 400 square feet of basal area per acre occurs in some stands, indicating localized conditions of high productivity, long-term exclusion of high-intensity disturbance, or both. Predominant Dothan formation soils incorporate a wide range of characteristics relating to site productivity, ranging from deep loams to sparsely vegetated surface rock.

Frequent fires as an agent of stocking control tended to produce stands that were occupied by widely spaced, older larger trees. Long-term fire exclusion resulted in stand size class distributions that tend toward dense stocking in the smaller size classes (seedlings and saplings), with stands at or in excess of natural carrying capacity. 1987 fire behavior was variable, with low to moderate intensity fires occurring over much of the landscape. Effects on vegetative structure and density characteristically included reduction or elimination of above-ground shrubs and small trees, with retention of most larger conifers and hardwoods. Within this low-to-moderate disturbance pattern, numerous "gaps" were created by small-scale intense flareups. Gaps range in size from a few trees to several acres in size. Approximately 15% of the burned area within the watershed experienced a high-intensity or "stand replacement" burn, where virtually all above-ground biomass was killed.

Successful artificial regeneration of managed stands combined with varying quantities of naturally-regenerated hardwoods and conifers in these stands generally results in early crown closure, recession of live crowns and greatly reduced diameter growth. Current high basal area levels and reduced growth in those natural stands where fire has been excluded may reflect the results of recent fire management policy. Stand density would be reduced if fires were allowed to burn, favoring within-stand diversity and more rapid development of a large tree component. Stocking level control of dense early and mid-seral stands is another management option that could be utilized in locations where accelerated diameter growth and increased live crown width and depth are desirable objectives.

3.1.6 LANDSCAPE PATTERNS

In Southwest Oregon, the acceptable range for well-functioning late successional conditions has been set at 40-75% (Regional Ecosystem Assessment Report, 1994). This range is not intended for any one watershed but for the landscape as a whole. The range of late seral conditions within Indigo Watershed (using individual sub-watersheds as a measurement unit) is 10-40%, with an average of 28%. Using the mid-point of the acceptable range as a baseline, a "deficit" of approximately 30% late successional habitat occurs within the Indigo Watershed[1]. Using localized conditions projected back to 1947, this deficit would be closer to 20%. To achieve this desired condition, acres of late successional habitat area would need to undergo an

[1] Range of deficit is 20-30% based on two sources; 1947 data and the REAP Report.

approximate twofold increase from current conditions.

3.2 WILDLIFE INTRODUCTION

The goal of this section of the Indigo Ecosystem Analysis is to furnish information that can be used to provide for the needs of wildlife while people use natural resources for our benefit.

The key question used to focus this wildlife portion of Indigo ecosystem analysis:

> What is, what was, and what is the trend for the relative abundance and distribution of species of concern that are important in the watershed (e.g. threatened or endangered species, special status species, species emphasized in other plans)? What is the distribution and character of their habitats?

3.2.1 Wildlife Species of Concern

Of the more than 200 vertebrate and thousands of invertebrate wildlife species that might be in the Indigo watershed, the wildlife species of concern are:

- Species federally listed as "proposed, endangered or threatened" by the Endangered Species Act,
- Species listed as Sensitive by Region 6 or Region 5 of the USDA Forest Service., or
- Species identified as "survey and manage," or "needing more analysis," or "management indicator species" by the Siskiyou Forest Plan as amended by the NW Plan.

Although distribution and abundance of species of concern and locations of individuals are important for managing species, a large data gap exists for most animals (Appendix A). Except for a handful of "listed" species, almost nothing is known about distribution and abundance in this watershed. Systematic surveys for a few species have been conducted, primarily in past project areas, and data about other species comes primarily from incidental sightings. Location information is important for maintaining wildlife that are threatened with extinction, such as peregrine falcons and northern spotted owls, because human activities that may have negative affects on nesting success can be avoided during breeding season. Peregrine falcons and northern spotted owls are known to nest in the Indigo Watershed.

Although location information is important to management activities near some species, habitat management has the greatest affect on all species. If adequate habitat for species of concern is not present in the watershed, these species will not be there. Conversely, if conditions they need are present, species of concern could occur in the watershed. Adequate habitat is a function of identifying appropriate habitat elements to measure, and determining the distribution (where) and abundance (how much) that is necessary for meeting the needs of wildlife. Although neither the appropriate habitat elements nor the distribution and abundance is known for all the species of concern, a considerable amount is known. Wildlife research has identified a host of habitat elements that wildlife need, and analysis can shed light on the distribution and abundance of these elements.

3.2.2 Habitat Elements

Habitat associations for wildlife species of concern in the Indigo Watershed were identified using information from Management of Fish and Wildlife Habitats of Western Oregon and Washington (Brown et. al., 1985) and the Siskiyou Forest Plan as amended by the NW Forest Plan. Habitat components that the species of concern are associated with are: grass/forb, shrub, seedling/sapling/pole, young forest, mature forest, old growth forest, caves & burrows, cliffs & rims, large down wood, snags, talus, and riparian/aquatic (Appendix A).

Habitats with the most vertebrate species of concern using them as primary habitat are:

- riparian/aquatic (18 species)
- old growth forest (17)
- Interior mature and old growth forest, as well as large trees with deformities - such as cavities, witch's brooms, and large limbs - are also identified as important wildlife habitat characteristics by the NW Forest Plan (see Appendix I, Table S-2b for a summary).
- mature forest (11)
- snags (15)
- large down wood (11)

Maintaining the appropriate distribution and abundance of these habitats is critical for meeting the wildlife goals of the Siskiyou Forest Plan as amended by the NW Forest Plan.

The amended Siskiyou Forest Plan standards and guidelines focus heavily on the habitat elements listed above and determined viability of many mature and old-growth and aquatic species is not at risk if the plan is followed. However, the amended Siskiyou Forest Plan also identifies many species whose viability are in question, and need more analysis. It also recognizes this plan is only one more step in America's desire to manage resources in the best way possible, and that through watershed analysis more steps can be taken. For example, the NWFP Plan (NWFP Plan FSEIS, pg. G-9) identifies potential future changes when it states: "The situation for [northern spotted] owls could be made more secure if favorable habitat conditions could be spread more evenly through the landscape [than the distribution identified by Late Successional Reserves]. Such a solution could be made possible if it can be demonstrated that silvicultural techniques can create and maintain suitable conditions while harvesting timber..."

3.2.3 Disturbance

The process of disturbance on habitat elements has profound effects on species distribution and abundance, and therefore ecosystem sustainability. Disturbances, especially fire, have changed the distribution and abundance of these habitat elements for millennia, and species are adapted to this natural range of variability. In fact, some species require disturbance. For example, ancient pine and Douglas fir trees reached large sizes because periodic low intensity fires removed competing vegetation.

Forest Ecosystem Management Assessment Team - FEMAT - (1993, p. II-98) states:

> "Change happens. Change is an inevitable and necessary attribute of biological systems. Species have evolved in an environment characterized by change, sometimes gradual as in succession, and sometimes sudden as in catastrophic storms or fires or as caused by human activities."

To provide the needs of wildlife species of concern, the range of changing conditions that they are adapted to should be sustained. The species of today are the result of their adaptations to the past, and their survivability can only be assured if the conditions they are adapted to are present. Understanding the conditions species have survived over the past few hundred years is important because the survival of species probably depends upon the presence of these conditions.

For deriving a first approximation of the natural range of habitat variability, analysis focused on attempting to understand how much habitat components have changed. Disturbance and site productivity influence these habitat elements. Site productivity is influenced heavily by climate and geology. Climate (especially available moisture) and geology (parent material for soil) have the greatest influence on a site's ability to produce these habitat elements. Good soil and high moisture availability combine to produce a lot of vegetation and a high amount of vegetation produces a lot of animals. Forest types of the Siskiyou National Forest were stratified into plant series that reflect how weather and soil parent material effect site productivity and how fire disturbance effects each plant series. (Atzet and Wheeler, 1984???).

Although the species of concern identified in this document have not been associated with plant series, the ability to produce important habitat components has. For example, the Jeffrey pine plant series (found on serpentine) does not normally produce big trees (over 32" dbh.) or canopy closure greater than 60%, for "old growth forest" but it does create conditions that produce many rare plants.

Maintaining a desirable range of variability for important habitat elements is dependent upon maintaining the effects of disturbance similar to the effects of past disturbances. Managing for conditions in the middle portion of the range of variability for any given habitat element is recommended (Atzet, personal communication, 1997). Analysis cannot completely define ranges, but approximations are made. Modification of these

"approximations" is expected to occur in the future as better information is obtained. The recommended "desired ranges" acknowledge that many extreme fluctuations of distribution and abundance of habitat elements are responses to factors outside human control; like climate change and severe fire weather conditions, they will happen regardless of our efforts.

3.3 FIRE REGIME (PREHISTORIC & HISTORIC)

3.3.1 General Overview

Fire has always been an integral part of the forest ecosystem in southwestern Oregon, and the Siskiyou National Forest, which have had a long history of wildfire occurrence (Payne 1983, Haefner 1975, Cooper 1939, Morris 1934). In the warm-temperate, dry-summer, Mediterranean" climate of the Siskiyou Mountains, the forests are easily set afire; and fires of widely varying intensities have been frequent (Whittaker 1960). Morris (1934), reporting on written accounts of major fire occurrence years in Oregon from the 1840's to the 1933 Tillamook Fire, notes fires in the southwestern Oregon area in the years 1853, 1857, 1864, 1867, 1868, and 1902. Soon after the establishment of the Siskiyou National Forest (1907), 179,000 acres burned in 1917 and 152,000 acres burned the following year. A total of 50,800 acres burned in 1938. Fires in 1987 were the third worst on record (Silver Fire-96,540 acres, Galice Fire-21,331 acres, & Longwood Fire-9,916 acres).

The distribution of fire in this Forest is extremely variable. There are places where 190-year-old trees show no evidence of fire. At the other extreme, a ponderosa pine had 11 scars (from fires in 1814, 1826, 1833, 1843, 1866, 1881, 1892, 1902, 1910, 1925, and 1980). A 30 year average fire cycle for the Mixed Conifer forest type was determined by Agee (1990) from forest survey work done in the 1940's by Andrews and Cowlin. Atzet and Wheeler (1982) determined fire cycles of 20 years for inland plant associations with cycle length increasing to 60 years or more for coastal areas. For this watershed, the natural fire cycle is between 20 and 40 years, depending on aspect, elevation and fuel model or plant series for low to moderate intensity fires, 50 to 70 years for moderate to high intensity fires, and large, stand replacement fires occurring every 200 to 300 years.

Atzet, Wheeler, and Gripp (1988) described the settlement period of 1820-1910 as a period when fire was forced on the land by trappers, miners, ranchers, and settlers to eliminate vegetation, drive game, enhance forage and clear land. Many of the 70 to 170 year-old age class stands on the Siskiyou are on sites burned by settlers and miners (Siskiyou Final EIS 1989). The intent was to burn off as much vegetation as possible. Burns were ignited during the driest, hottest weather possible, and were more frequent than natural fires.

Records from the Siskiyou National Forest give an indication of the extent of burning. Hundreds of thousands of acres burned in the early part of this century, as shown in Table 3.3. After 1940, when the smoke jumper base was installed at Cave Junction, significantly fewer acres burned until 1987.

Reports on the 1987 fires indicate that between 12 and 27 percent of the area within the fire perimeters burned at stand replacement intensity. Records of the Cedar Camp fire in 1937 indicate similar proportions of high intensity fire (12%). Note the cover photo (Gripp, internal Forest Service Report).

Thus, fire frequency for prehistoric or pre-settlement times is a better reflection of the natural role of fire in the ecosystem than data from more recent times, due to the intensity of burning during the settlement era. Specific records for the previous century are not available, but U.S.G.S. reports indicate virtually all areas surveyed were burned (Leiberg, 1900). Because little is known about the severity of pre-historic fires, reconstruction of historic proportions of seral stages is tentative. According to Native Americans, fire was used extensively for the last 10,000 years. Therefore, the recent reduction of fire is new to the ecosystem.

3.4 FIRE FREQUENCY & RISK - CURRENT CONDITIONS

3.4.1 Fire Exclusion Effects

Effective fire suppression programs have, therefore, created a relatively fire-free condition during the

last half of this century. Atzet and Wheeler (1988) found few fire scars on trees in stands less than 70 years of age. Fire suppression has reduced the occurrence and the numbers of acres burned. Thomas and Agee (1986) found that fire suppression has effectively eliminated up to five fire-cycles in the mixed-conifer forests of southwestern Oregon. This has lengthened the fire-free period vegetation has previously experienced.

TABLE 3.3
NUMBER OF ACRES BURNED
(SISKIYOU NATIONAL FOREST, 1910-1996)

Decade	Acres Burned
1910-1919	410,369
1920-1929	60,813
1930-1939	153,812
1940-1949	4,157
1950-1959	5,805
1960-1969	4,601
1970-1979	2,942
1980-1989	112,822
1990-1997	10,358
Total	**765,679**

Charred snags, charcoal in the soil, even-aged stands, and fire-scarred trees are all evidence of past fires. In most cases, the year of the burn can be estimated. Fire scars are the most accurate evidence and often reveal fire frequencies and indicate intensity. Species or age-class patterns can estimate old fire boundaries.

An analysis of fire occurrence was made based on fire occurrence records from the Siskiyou National Forest. This data is from all fire reports on record for any fire within the Indigo Watershed from 1941 to 1997. Fires over 5 acres in size, burned a total of 21,103 acres during this period. The single largest fire burned 20,536 acres in this Watershed. By Sub-watershed this breaks out to be 87% in the Indigo Sub-Watershed, 79% in the West Fork Sub-watershed, 62% in the East Fork Sub-watershed, and 49% in the Breezy Sub-watershed. During this 56-year period 47 fires (0.84 per year) were recorded as started in this watershed. Twenty-one of these fires (0.38 per year) were caused by lightning and 13 had no recorded information on cause. The remaining 13 fires (0.23 per year) were person-caused.

Table 3.4 shows the fire history by cause for the Indigo Watershed, from 1941 to 1997.

TABLE 3.4
FIRE HISTORY (1941-1997)

Cause Of Fire	No. Of Fires	Frequency
Lightning	22	45%
Human	13	28%
Unknown	03	06%
No Information	10	21%
Total	48	100%

Table 3.5 indicates a breakdown by year of fires over 5 acres in size during the 1941 to 1997 period.

TABLE 3.5
FIRES OVER 5 ACRES IN SIZE (1941 - 1997)

YEAR	SIZE (ACRES)
1956	114
1959	24
1964	74
1967	282
1972	60
1987	20,536
1988	13
Total	21,103

Table 3.6 summarizes a breakdown of the Sub-watersheds acres, acres burned, percent burned and fire starts during the 1941 to 1997 period.

3.4.2 Fire Regime, Role, and Hazard

Fire regimes are a function of growing environment, ignition patterns, and plant species characteristics (Agee 1990). Temperature and moisture make up the growing environment. Lightning and humans cause ignition patterns. Plant species characteristics are a result of adaptation to fire and fuel accumulations.

Many natural stands in the watershed have two and three multi-aged cohorts as a result of frequent surface fires. The layered understory vegetation can contribute to high-intensity fires due to waxy-leaved shrubs and trees carrying flames into the overstory. Tanoak will sprout from the roots

following intense fires, and a dense canopy of tanoak will form. If Douglas-fir is mixed in the stand it will take up to 30 or more years to outgrow and dominate the tanoak. In older stands, when Douglas-fir begins to break-up, tanoak established in the understory is released. This is occurring in many stands in the watershed and tanoak will also release following partial cutting of the overstory Douglas-fir. Very high intensity fires or successive intense fires may result in nearly pure hardwood stands.

TABLE 3.6
FIRES BY SUB-WATERSHED (1941 - 1997)

Sub Watershed	Acres	Burned Acres	% Burned	Fire Starts
Brandy	903	0	0%	1
Breezy	1547	757	49%	2
Chief	1763	0	0%	5
East Fork	7979	4909	62%	5
Indigo	10,793	9372	87%	9
Lazy	1654	35	2%	1
North Fork	8494	588	7%	8
Slim	761	0	0%	2
Snail	3721	364	10%	6
Upper E. Fork	2029	192	9%	2
Upper W. Fork	3235	0	0%	2
West Fork	6184	4886	79%	5
Total	**49,064**	**21,103**	**43%**	**48**

Fire has a natural role in the vegetative community in any watershed. Vegetation adaptation to fire has accounted for its persistence over time. The exclusion of fire for most of this century has created an unnatural ecosystem. Fuel has accumulated over longer periods than would occur naturally. Shrub and understory vegetation has not been "set back" as would have typically occurred and now presents an abnormal fuel ladder in many stands. The artificial exclusion of fire has altered the natural fire regime. The natural fire regime would normally create a mosaic of high, moderate, and low intensity burning. A mosaic of forest patches is created and maintained by moderate-severity regime fires. The size of these patches is largely determined by length of return interval, aspect, and slope.

Exclusion of fire can also reduce the natural mosaic pattern in vegetation heights and age classes, creating larger contiguous areas of vegetation of uniform heights and uniform fuel conditions. This creates an increase in areas experiencing similar wildfire behavior and can result in a more uniform fire intensity occurrence. Natural old growth forests typically have an uneven mosaic of size classes, which act as a buffer from catastrophic crown fires (Kauffman 1990). This buffer effect is lost as vegetation becomes more uniform. Species diversity is reduced when disturbance is reduced. With infrequent disturbance, species composition and stand structure tends to stabilize. Climax species dominate and pioneer species are reduced or eliminated. Nature consistently introduces disturbance which maintains a diversity of both pioneer and climax species.

Additional habitat types found in the watershed are open meadows. They are important as forage areas for deer and elk. Some of the meadows, with deeper soils, will move toward open grown tree overstories, and are currently experiencing tree encroachment, due to fire exclusion.

Organic matter, in the form of large woody material and litter on the forest floor, are important to forest productivity. Fire plays an important role in the creation and loss of large woody material. Fire is the primary agent for the breakdown of large woody material in forests with fire frequencies of less than 50 years (Kauffman 1990). Fire also has a strong

effect on the rate of input of woody debris into the system. Fires kill living trees creating new large woody material as they consume existing debris.

A fire in late summer or early fall can consume up to 85 percent of the debris (Kauffman and Martin 1985). Wildfires burning with much higher intensities than occurred naturally could drastically reduce the amounts of woody debris and affect the replacement cycle by also consuming sources of replacement material.

Organic matter, in the form of soil organic matter, litter and duff, and shrubs and trees, are important as nutrient reserves. Losses of these from fire may reduce productivity by lowering total moisture on the site and the nutrient holding capacity. A loss of 22 percent of total organic matter was reported for the Silver Fire (Silver Fire Final EIS 1988). Duff and litter levels on the study area are thin and most nutrients are held in the live vegetation (McNabb and Cromack, 1990). Accumulations of litter increase with the exclusion of fire. This will increase nitrogen and organic matter on the forest floor. Frequent fires that burn less intensely may consume the forest floor without destroying most of the overstory or damaging the soil. Infrequent fire burns with higher intensities and volatilizes a higher percentage of nutrients, above ground and in the soil. Because of this, frequent fires are considered less damaging to productivity than infrequent, more intense, conflagrations (Waring and Schlesinger 1985).

Vegetation changes from altering the fire regime include increases in the amount of tanoak, and of shade-tolerant conifer species in the understory. Species such as white fir, grand fir, and incense cedar are fire-intolerant. They change both the horizontal and vertical structure of the forest, and can change the fire behavior and intensity level by providing an increase in flammable ladder fuels in the understory. Tanoak can successfully germinate and survive under a conifer understory and has probably increased in abundance as a result of fire exclusion. This can have a similar effect of providing an increase in fuel ladder in the understory.

The total amount of small (1inch to 9 inch) dead woody material in this watershed is believed to be above historic levels, while the amount of large (9 inch to 20+ inch) woody material is probably below historic levels. This is result of fire suppression and exclusion. In natural (unmanaged) stands fire suppression and resulting fire exclusion has resulted in increases of total material above historic levels, as the smaller material has not been consumed by late summer/fall, naturally occurring, fire. Large wood in these unmanaged stands, on the other hand, has not been added to the system as rapidly as would have occurred under a natural fire regime. Managed stands in the watershed are areas that do not approximate historic levels, for both total small dead woody material and large wood. This is a result of clear cut harvesting, removing of large woody material, and fall prescribed burning. Within the last ten years large material has not been removed from the clear cut units, and spring prescribed burning does not consume the large material because of the higher fuel moisture content within these logs. These more recent stands are closer to the historic levels of large woody material than the older clear cuts. Consequently, large woody material is probably below historic levels in 57% of the watershed (except possibly within the 43% where the 1987 fires occurred) and total small downed woody material is much above historic levels.

Since the tracking of fire starts and acres within this watershed (1941), 43% of the area has burned, with the largest amount of acres encompassing 20,537 acres. Within this analysis area and within this large fire event six plots of fuels surveys and photos were studied. The plots were set up in 1989 (2 years after the fire) with photos and inventories, and rephotoed and inventoried in 1993. The fuel loading in 1993 ranged from 12.9 tons of fuel per acre to 29.4 tons of fuel per acre. Most of the tonnage's were within the 3 inch to 9 inch fuel class. Standing snags ranged from 5.2 per acre to 112.9 per acre, size class of these snags range from 9.8 dbh to 32.8 dbh. Hardwoods will start their decline in 5 to 10 years after they are killed and conifer can range from 7 years to 30 years depending on size. In essence 43% of this analysis area will have a fuel loading of 50 tons per acre or more in the 9 inch to 20 inch material, due to the standing snags that will start to decline (1998 will be 10 years since the first fuel inventories were set up).

Using PMR (Pacific Meridian Resources) data, Seral stage structure of Pioneer, early seral, mid-seral, late seral, and climax vegetation condition classes these values were grouped to create a fuel model map for determining fire behavior. Five fire behavior fuel model categories are within this report:

Fuel Model 5 (Shrub group). Fire is generally carried in the surface fuels that are made up of litter cast by the shrubs and the grasses or forbs in the understory. The fires are generally not very intense because surface fuel loads are light, the shrubs are young with little dead material, and the foliage contains little volatile material. Usually shrubs are short and almost totally cover the area. Young, green stands with no dead wood would qualify: laurel, vine maple, alder, or manzanita. Rate of spread for this model is 18 chains per hour with a flame length of 4 feet.

Fuel Model 6 (Shrub group). Fire will carry through the shrub layer where the foliage is more flammable than fuel model 5, but this requires moderate winds, grater than 8 miles per hour at mid flame height. Fire will drop to the ground at low wind speeds or at openings in the stand. This model covers a broad range of shrub conditions. Fuel situations to be considered include intermediate stands of oak brush and ceanothus. Even hardwood slash that has cured can be considered. Rate of spread for this model is 32 chains per hour with a flame length of 6 feet.

Fuel Model 8 (Timber group). Slow-burning ground fires with low flame lengths are generally the case, although the fire may encounter an occasional "jackpot" or heavy fuel concentration that can flare up. Only under severe weather conditions involving high temperatures, low humidities, and high winds do the fuels pose fire hazards. Closed canopy stands of short-needle conifers or hardwoods that have leafed out support fire in the compact litter layer. This layer is mainly needles, leaves, and occasionally twigs because little undergrowth is present in the stand. Representative conifer types are sugar pine, white pine, lodgepole pine, spruce and fir. Rate of spread for this model is 1.6 chains per hour with a flame length of 1.0 feet.

Fuel Model 9 (Timber group). Fires run through the surface litter faster than model 8 and have longer flame height. Both long-needle conifer stands and hardwood stands. Fall fires in hardwoods are predictable, but high winds will actually cause higher rates of spread than predicted because of spotting caused by rolling and blowing leaves. Closed stands of long-needled pine like ponderosa are grouped in this model. Concentrations of dead-down woody material will contribute to possible torching out of trees, spotting and crowning. Rate of spread for this model is 7.5 chains per hour with a flame length of 2.6 feet.

Fuel Model 10 (Timber group). The fires burn in the surface and ground fuels with greater fire intensity than the other timber litter models. Dead-down fuels include greater quantities of 3-inch or larger limbwood resulting from overmaturity of natural events that create a large load of dead material on the forest floor. Crowning out, spotting, and torching of individual trees are more frequent in this fuel situation, leading to potential fire control difficulties. Any forest type may be considered if heavy down material is present: examples are insect- or disease-ridden stands, wind-thrown stands, overmature situations with deadfall, and aged light thinning or partial-cut slash. Rate of spread for this model is 7.9 chains per hour with a flame length of 4.8 feet.

Table 3.7 displays a breakdown of fire behavior fuel models and the PMR seral stage classes with the watershed acres.

3.4.3 Desired Future Condition

A reduction in the potential for large, high intensity, wildfire is desired in order to meet anadromous fish habitat and other ecosystem function objectives. This potential can be reduced by manual vegetation manipulation and/or prescribed burning to produce conditions limiting fire spread and high intensity burns.

Vegetation manipulation efforts would be designed to decrease fire rate of spread and reduce intensity to prevent stand replacement fire events. These efforts include stand density management, slash disposal, use of prescribed burning to reintroduce fire in natural stands, and utilization of natural and

other barriers to limit fire spread. Specific examples could be:

- ✓ Thinning with removal or treatment of activity and accumulated natural downed woody fuels to reduce fuel ladders and fuel loadings, and increase fire tolerance;
- ✓ Creation and maintenance of fuel breaks along key ridge tops or water ways and along private lands;
- ✓ Mechanical understory removal or underburning to reduce ladder fuels;
- ✓ Long-term maintenance of natural fire regimes through prescribed burning.

TABLE 3.7
FIRE BEHAVIOR FUEL MODELS

Fuel Model	PMR Type	Rate of Spread.	Flame Length.	Acres
5	Pioneer	18	4	11,268
6	Shrub	32	6	2,745
8	Mid	1.6	1	8,709
9	Early	7.5	2.6	12,844
10	Late/Climax	7.9	4.8	13,497
Total				**49,045**

Fire needs to be used when the stand conditions are right and when prescriptions are right. In some situations it is important to bring thinning and other silvicultural treatments ahead of fire use, to reduce the biomass in these fire-dependent forests before we can prescribe burn at the right intensities.

Within this watershed analysis area 41,190 acres of the 49,064 acres is in Late Successional Reserves (LSR). As written in the Southwestern Oregon LSR Assessment, wildfire is allowed to occur, under conditions which would provide beneficial effects for the LSR, also prescribed fire may be implemented for the purpose of hazard reduction to prevent, or reduce the probability of a stand replacement fire.

3.4.4 Native American Burning in Southwest Oregon

Restoring ecosystem function is one of the many goals of the Aquatic Conservation Strategy for Tier II Key Watersheds located in west-side owl forests. Fire is an important aspect of ecosystem function in southwest Oregon. Major plant communities are dependent on fire and other types of disturbance to successfully maintain ecosystem health (Atzet and Martin 1991). Native American communities have occupied southwest Oregon for at least the last 8000 years (Aikens 1993). During that time aboriginal groups actively "managed" portions of their environment, often using fire as a management tool. While it may be difficult to isolate Indian burning from the natural fire cycle, native Americans played an active role in maintaining fire dependent communities over time and in establishing themselves as the dominant "edge dependent species" (Bean and Lawton 1993; Lewis 1989, 1993).

There are numerous parallels between present day management objectives in fire ecology and Indian burning. Both seek to maintain an array of early to mid-seral plant communities across the landscape. Such communities provide small and big game habitat, natural fuel breaks, and for native populations various edible plant foods and materials for basketry and other technological uses. Other uses for Native American fires included hunting, crop management, insect collection, pest management, warfare, preparing foods, and clearing areas for travel (Williams 1993). Fire also recycles nutrients, provides vistas, and often destroys forest pathogens. See Williams (1993) for a recent bibliography of use of fire by Native Americans.

Specific ethnographic information for the use of fire in southwest Oregon is limited (Lewis 1989). Detailed information is available for the Willamette Valley (Boyd 1986), however, and it is possible to extrapolate techniques to native populations in the Rogue Valley area based on similarities of plant communities. Plant communities that occur in northern California such as mixed brush also extend into southern Oregon and ethnographic data is available for burning by those tribes. Indian practices of burning in southwest Oregon must have functioned similar to those described for such tribes as the Miwok, Hupa, Tolowa and Wintun (Lewis 1989, 1993).

Native American burning occurred in three broadly defined plant communities in southwest Oregon: oak-grasslands, mixed brush, and forested areas. The following review is based on Lewis (1989). For a more detailed discussion see Lewis (1993).

Oak-grasslands: These plant communities were fired beginning as early as late July and continuing through September. This commonly occurred after spring rains. Burning initiated early growth of grasses and provided habitat for game. Burning also controlled acorn destroying insects (McCarthy 1993).

Mixed brush: Fires were usually initiated in the fall. The primary goal was to maintain a mosaic of early to mid-seral plant communities that functioned as small and big game habitat. Edible plant species were also produced. This mosaic created natural fuel breaks. Spring burning helped to maintain more permanent openings. Fire was also used to create seedbeds for planting of tobacco; tobacco was the only "cultivated" plant species.

Forested Areas-Dry: Fires were usually initiated in the late summer or fall. Fire was used to maintain open understories in stands dominated by Douglas fir and ponderosa pine. Fires eliminated the build up of ladder fuels that could contribute to stand replacement fires. In all cases fire provided forage for game.

Forested Areas-Wet: No information is reported for native burning in mesic coastal forest. However, fire was probably used to maintain "prairies" and grasslands as game habitat and to control tree encroachment in the late summer or fall seasonal times.

In summary, Native American burning maintained a diversity of habitats across forested landscapes. Given the lack of specific ethnographic data for southwest Oregon it may be difficult to separate Native American burning from the natural fire regime. However, it is possible to extrapolate from areas with known data and similar plant communities to use patterns of Native American burning as a possible guide for management ignited fires. Native American ignited fires maintained the amount of "edge" or ecotones across the landscape. In this context, aboriginal peoples were the ultimate "edge loving species" (Lewis 1993). Edges are one of the most productive habitats for both plants, animals, and people. The long occupation of southwest Oregon by aboriginal peoples and their use of fire to maintain certain landscape features calls into question the idea that native peoples were passive in relation to manipulating their environments (Thomas and Anderson 1993). Given this context, the desired future condition of specific watersheds would using both natural and human create a mosaic of plant communities caused fire within specific management objectives.

3.5 INDIGO BOTANY

3.5.1 Existing Conditions and Trends

Outside of West Indigo Creek in 1991, much of the entire Indigo Creek watershed has not been surveyed for sensitive plant species. Some of the FSEIS, Appendix J2 or ROD, Table C-3 Survey & Manage species have been surveyed for within the watershed. The low density of roads and trails, the rough and rugged terrain, and the steep canyon walls of Indigo Creek have been a deterrent to the accomplishment of botanical surveys in this watershed. These factors will continue to be a deterrent in the future.

There are no Federally listed Threaten and Endangered plant species known to occur within the watershed. However, there are 6 sensitive species known to occur within the watershed: *Arctostaphylos hispidula*, *Bensoniella oregana*, *Cupressus bakeri*, *Encalypta brevicolla* spp. *crummiana*, *Erigeron cervinus*, *Erigonum lobbii*, *Frasera umpquaensis*, *Fritillaria glauca*, *Hazardia whitneyi* var. *discoidea*, *Iliamna latibracteata*, *Monardella purpurea*, and *Triteleia hendersonii* var. *leachiae*. One of the species is a Federal Candidate species (see Table 23) and all are category 1 or 2 listed species in the state of Oregon, or as a Federally listed species. One if these species are a category 1 listed species in the state of California. Several other species are category 3 or 4 listed species in the states of Oregon and/or California. Additionally, *Allotropa virgata*, a FSEIS, Appendix J2 or ROD, Table C-3 species (Survey and Manage) is known to occur from data collection efforts in the watershed in the past (see Table 3-11).

Four species on Oregon Natural Heritage Program's List 3 (proposed sensitive species) are found within the watershed: *Asarum caudatum*, *Hieracium greenei*, *Leucothoe davisii*, and *Saxifraga fragaroides* (see Table 3.10). While 3 species found

on Oregon Natural Heritage Program's List 4 (watch) are known to occur within the watershed (see Table 3.9).

Plants listed by the Oregon Natural Heritage Program (O. N. H. P.) as List 3 (Proposed Sensitive), or List 4 (Watch) do not require mitigation for project implementation. However, their occurrence should be documented and monitored to see if a particular species is in need of removal from the list, or it requires a higher protection status to maintain population viability.

Survey & Manage species designation originated within the Record of Decision (ROD) for Amendments to Forest Service and Bureau of Land Management Planning Documents Within the Range of the Northern Spotted Owl sign in April of 1994. Survey & Manage standard and guideline measures apply within any land allocation. However, the survey and manage provision for each species is directed to the range of that species and the particular habitats they are known to occupy. This management classification provides benefits for the amphibians, mammals, bryophytes, mollusks, vascular plants, fungi, lichens, and arthopods listed in Table C-3 of the ROD. Standard and guidelines for the 234 fungi species, 81 lichen species, 23 bryophyte species, and the 17 vascular plants are broken into four categories (Table 3.8).

TABLE 3.8
NWFP SURVEY & MANAGE CATEGORIES

Survey Strategy	Management
1	Manage known sites
2	Survey prior to activities and manage known sites
3	Conduct extensive surveys and manage known sites
4	Conduct general regional surveys for additional information

Beginning October 1, 1998 all 335 fungi, lichen, bryophyte, and vascular plant species found in Table C-3 of the ROD must be surveyed and managed for before any project can be initiated on the Federal land covered under the ROD. Currently, only a handfull of these species were surveyed and managed since the signing of the ROD

TABLE 3.9
SURVEY & MANAGE SPECIES FOUND IN THE INDIGO CREEK WATERSHED:

Scientific Name	Common Name	Survey Strategy
Allotropa virgata	Candy Stick	1 and 2

The Indigo Creek watershed is quite diverse from the botanical standpoint. With the diversity of habitats present within this watershed, the probability of discovering additional sensitive plant species or populations is high. Potential habitats for sensitive plant species would include: serpentine, non-serpentine, coniferous forest, open dry places, rock outcrops, talus, and riparian locations. The botanical diversity found in the Indigo Creek watershed is, in part, related to the diverse geology in the watershed. The North Fork Indigo Creek watershed contains a large block of gabbro (about 90% of watershed) that supports some rare or unique plant species populations. Approximately 14% of the entire Indigo Creek watershed contains Gabbro parent material in either tuff or dike formations. Populations of *Eriogonum lobbii*, first discovered in Oregon in 1984, are only known to occur in the Indigo Creek watershed and appears to be confined to soils that develops from gabbro. Approximately 80% of the Indigo watershed contain soils derived from the Dothan Formation. The Dothan formation is composed of late Jurassic sedimentary and volcanic rock, intermixed with serpentine and blue schist. Serpentine geology (about 3% of watershed) provides dry, vernally wet, and wet habitats for serpentine endemic and non-endemic plant species. The largest populations of *Darlingtonia californica* found on the Galice Ranger District occur in bog - like habitats. Bog habitats, where *Darlingtonia californica* often are found, are generally associated with other sensitive species as well.

Approximately 43% of this watershed was burned during the 1987 wildfires (Silver Complex Fire), providing habitat for those sensitive plant species requiring early seral stage conditions.

Table 3.10
Sensitive Plant Species found in the Indigo Creek Watershed:

Scientific Name	Common Name	Federal Status	Oregon Status	CA. Status
Arctostaphylos hispidula	Howell's manzanita	2	4	
Bensoniella oregana	Bensonia	2	1	1
Cupressus bakeri	Baker's cypress	2	4	
Encalypta brevicola ssp. *crumiana*	Snifter moss		1	
Erigeron cervinus	Siskiyou daisy	2	3	
Eriogonum lobbii	Lobb's buckwheat		2	
Frasera umpquaensis	Umpqua frasera	2	1	2
Fritillaria glauca	Siskiyou fritillaria		2	
Hazardia whitneyi var. *discoidea*	Whitney's haplopappus		2	
Illiamna latibracteata	California globemallow		2	4
Monardella purpurea	Siskiyou monardella		2	4
Triteleia hendersonii var. *leachiae*	Leach's Brodiaea		1	

Status Codes: Fed - Federal Status. OR - Oregon State Status. CA - California State Status

Federal Status #2 denotes species in need of additional information in order to propose as Threatened or Endangered under the Endangered Species Act.

Oregon Status #1 denotes taxa that are threatened with extinction or presumed to be extinct throughout their entire range.

Oregon Status #2 denotes taxa that are threatened with extirpation or presumed extirpation from the state of Oregon.

Oregon Status #3 denotes taxa that are on a review list for threatened and endangered species in Oregon or throughout their range.

Oregon Status #4 denotes taxa that are on a watch/monitor list but are not currently threatened or endangered.

California Status #1 denotes same as Oregon Status.

California Status #2 denotes same as Oregon Status.

California Status #4 denotes same as Oregon Status.

TABLE 3.11
PROPOSED SENSITIVE AND WATCH LISTED PLANT SPECIES FOUND IN THE WATERSHED:

Scientific Name	Common Name	O.N.H.P. Status
Asarum caudatum	White-flowered wild-ginger	3: Proposed Sensitive
Hieracium greenei	Green's hawkweed	3: Proposed Sensitive
Leucothoe davidisii	Sierra laurel	3: Proposed Sensitive
Saxifraga fragaroides	Strawberry saxifrage	3: Proposed Sensitive
Arabis koehleri var. stipitata	Koehler's rock-cress	4: Watch
Cypripedium californicum	California ladyslipper	4: Watch
Montia diffusa	Branching montia	4: Watch

O. N. H. P. = Oregon Natural Heritage Program.

The Indigo Creek watershed contains many plant species, or combination of species, that are unique (not necessarily sensitive species) with respect to other Siskiyou National Forest watersheds, southwest Oregon, or the Klamath Mountain Provenance. *Kalmiopsis leachiana*, for which the Kalmiopsis Wilderness Area was named, is a southwest Oregon endemic species. Good sized populations of this species can be found within the adjacent Silver creek watershed. *Leucothoe davisiae* is documented adjacent to this watershed as well, a species uncommon in southwest Oregon. It is a single - species genus found only in North America in the Klamath and high elevation Sierra Nevada Mountain Ranges.

3.5.2. General Comments

Populations of *Kalmiopsis leachiana*, found in the 1987 Silver Complex Fire, are being monitored.

The identification of population locations, with approximate size and associated vegetation data, is the extend of current knowledge of the sensitive plant populations within these watersheds. None of the known sensitive species populations have been monitored by any protocol approved for the species.

The populations of a species of *Vaccinium* (*V. scoparium*, also called *V. myrtillus*) are found within the Indigo Creek Watershed. This species is associated (larva food plant) with a sensitive butterfly species, the Mariposa Copper. This *Vaccinium* species is considered rare in the California part of the Klamath Mountains; the majority of the populations of this species are found to the North of the Klamath Mountains. The populations found within the Indigo and adjacent Silver Creek Watersheds are perhaps the southern most populations that will effectively support Mariposa Copper butterfly populations.

Most of sensitive species known to occur within this watershed does not have management guidelines written for them (draft or final). With most of these sensitive species, little is known about their ecological processes, reproductive biology, long-term survival requirements, or long-term population trends. No trend data is available for any of the sensitive species found within the watershed.

One sensitive species has a final management plan written for it as part of a cooperative effort between the US Forest Service and the Bureau of Land Management. This species is *Frasera umpquaensis*. A draft management plan is available for *Arctostaphylus hispidula*, *Bensoniella oregana*, and *Monardella purpurea*. These documents contain management recommendations, based on current knowledge of the species that should increase their long-term survival.

Known botanical resources located on the Medford District of the Bureau of Land Management (BLM) lands within this watershed would be available to the US Forest Service either directly through the BLM or the Oregon Natural Heritage Database (Biological Conservation Data or BCD). We have some knowledge of sensitive species locations on BLM managed lands through BCD. Little is known about the botanical resources on private lands found within this watershed.

3.5.3 Port Orford Cedar

One other species of concern found within the Indigo Creek watershed would be Port-Orford-Cedar (*Chamaecyparis lawsoniana*), which can be killed if infected by a root-rot fungus (*Phytophthora lateralis*). Port-Orford-cedar (*Chamaecyparis lawsoniana*) can be found in small populations within the Indigo Creek Watershed. Although not considered a Threatened and Endangered or sensitive species, Port-Orford-cedar has recently become more of a concern due to its susceptibility to a root-rot-fungi (*Phytophthora lateralis*). Port-Orford-cedar is likely to occur, to some degree, in all the subwatersheds. The species is highly susceptible to the root rot with little resistance known to occur.

Spores of the root-rot fungi are spread by water, especially flowing water. Spread of spores is most prevalent during periods of precipitation. Concurrently, Port-Orford-cedar is a species associated with moist sites or riparian zones and is primarily found adjacent to flowing water on the eastside of the Siskiyou National Forest. Eastside Port-Orford-cedar habitat is prime root-rot habitat. Below ground root grafts can also spread the root-rot fungi from trees adjacent to flowing water, to other trees some distance from the source of the infection. Large number of individuals can be killed if the spores are introduced into a previously uninfected drainage.

Currently, the root-rot fungus is known to be present in the headwaters of North Fork Silver Creek, an adjacent watershed. Infection has killed Port-Orford-cedar trees in the drainage about one mile downslope from Soldier Camp Saddle on lands managed by the Medford District of the Bureau of Land Management. Transportation vectors such as vehicles and heavy equipment have the potential of infecting Port-Orford-cedar populations in the Indigo Creek Watershed. Prevention strategies to maintain Indigo Creek Watershed in a disease-free condition should be undertaken.

3.5.4 Introduced Species and Noxious Weeds:

The probability is large that not all non-native grasses or other introduced species within these watersheds are known, however, there are several that have been identified.

Previous roadside erosion control measures have used some grass species that were not native to the watershed. Introduced grass species used within the watershed were ones where seed was available for agricultural use. Seed from native grass species was not available. A mixture of grass species known as the "Siskiyou mix" was used to seed along road systems to reduce erosion and was likely applied within this watershed. This mix consisted of orchard grass (*Dactylis glomerata*), perennial rye (*Lolium perenne*), cereal rye (*Lolium spp.*), fawn fescue (*Festuca spp.*), timothy (*Phleum pratense*), and white Dutch clover (*Trifolium repens*). Large areas of the Silver Fire Complex (1987) were seeded with annual rye (*Lolium multiflorum*), a non-native grass seed species.

The introduction of other "weed" species has occurred in association with past activities. Populations of yellow starthistle (*Centaurea solstitialis*) are known to occur on the Siskiyou National Forest. Yellow starthistle is a species native to the Mediterranean first introduced in California in the 1860's, now spreading about 5,000 acres annually. Infestations are currently estimated to be abo ut 10 million acres in California, 280,000 acres in Idaho, 148,000 in Washington, and at least 135,000 acres in Oregon. Starthistle can be found near the Indigo Watershed at Sourgrass Camp in a BLM gravel pit along the FS 2411 road. These populations likely started from seed that was transported on soil remaining on heavy equipment used for road construction or timber harvest activities, from private vehicles traveling around the forest, or via contaminated hay used in road decommissioning or horse feed. This species has become a serious problem in dry, disturbed habitats where introduced. Other introduced thistle species include Bull thistle (*Cirsium vulgare*) and Canada thistle (*Cirsium arvense*).

Klamath weed (*Hypericium perforatum*), also known as St. Johnswort, is another widespread noxious weed found on the forest. A native of Europe is invades rangeland and disturbed areas along road systems and is poisonous to livestock. Stock seldom eats the plant unless other forage is scarce, but the poison appears to be cumulative. Scientists have been re-introduced to the medicinal uses for this plant. The plant is abundant west of the Cascade Mountains, as well as several counties in eastern Oregon.

Scotch broom (*Cytisus scoparius*) is a noxious weed from the leguminosae, or pea family. It is wide spread in western Oregon, where it was originally introduced as an ornamental and has since escaped cultivation. The plant is native to Europe and has become a nuisance in pastures, fields and forest areas, crowding out the native vegetation in its path. In the Indigo Creek Watershed scotch broom can be found approximately one mile west of Raspberry Mountain on the Burnt Ridge road, south of Indigo Prairie at the end of the FS 2308761 road, and along the Bear Camp road near Buck Camp.

3.5.5 Botanical Processes

From a botanical standpoint, the effect of naturally occurring events or management activities on sensitive plant species would need to be evaluated at the species level for any population in, or near, an activity area. Some sensitive species benefit from early seral stage conditions created by ground disturbance or naturally occurring events (wildfire), however, many of the species known to occur within this watershed generally do not fall into this category. One species, *Frasera umpquaensis*, is found in habitats that are different than the Cascade Mountain populations. The Siskiyou populations are more tolerant of higher summer temperatures and are not associated with a mesic environment found in the Cascade Mountain populations. Another species, *Gentiana setigera*, is associated with wet areas, particularly *Darlingtonia californica* bogs. Some species are serpentine endemics and are found only on ultramafic geology, while others appear to be associated with gabbro geology. The need to maintain habitats for all native botanical species should be addressed, particularly the sensitive species.

The vegetative material used within this watershed in the future should be naturally occurring or native species. Care should be taken to use "local" vegetative sources of material that would be adapted to the watershed. The use of native species from non-local sources could create undesirable populations by genetically "contaminating" the local races. It may be more desirable to use short-lived, "neutral" introduced species, that could be

readily identified at the site in the future, then a non-local race of a native species that could not be separated from local occurring individuals.

Reducing or eliminating introduced plant species populations would be desirable, however, other concerns should be evaluated before implementation of projects related to non-native species. With some species it could well be impossible to eliminate them altogether.

Roadways with bare soil are avenues for introduction of "weed" species and provide travel corridors for them as well. Open or bare-soil conditions along roadways should not be permitted, if preventable. Another vector for introduction of noxious weeds is the use of heavy equipment previously used at locations where undesirable weed species occur. Noxious weed seed can adhere to the soil remaining on the equipment and then dislodged at forest sites if the equipment is not cleaned before entering the watershed.

3.5.6 Desired Condition

The desired botanical condition would be to maintain the present botanical diversity of all native plant species within the watershed. In order to maintain or enhance populations of the many known sensitive species within the watershed, a wide range of habitat conditions would need to be maintained. The specific habitat requirements of each individual species would need to be determined and maintained within the watershed. With many species, additional habitats could not be created for them. A balance of habitats associated with different seral stage conditions would assure that a wide range of niches was available for native plant species within the watershed.

Another desired condition would be to reduce or remove completely non-native plant species from forest ecosystems. This may not be practical to achieve with all introduced species that may be present.

3.5 7 Restoration Activities

The restoration activities that would benefit the botanical resources within these watersheds would be those that maintained the diversity of habitat conditions for native species now found there. With sensitive species that require early seral stage or disturbed habitats, the removal of dense canopy conditions or burning of habitats would benefit them. With those species requiring late seral stage habitat, some stands may need total protection and growth accelerated by silvicultural practices in some younger stands.

The final management guideline for *Fraser umpquaensis* has identified selected populations that are critical to maintain the genetic viability of the species. All Siskiyou National Forest populations are "selected" populations. As such, the conservation strategy calls for no further human-caused impacts, such as logging and recreational structures (trails, campgrounds, etc.). Further, the strategy calls for up to 600 foot buffers around populations to minimize edge effect and protect potential habitat; these populations may be sensitive to temperature and relative humidity changes.

Some plant species within this watershed are dependent on habitats with frequent wildfire (*Kalmiopsis leachiana*, as an example). Fire prevention measures have allowed for habitat conditions much differ from those of the past. The reintroduction of fire would be desirable and help to create habitat conditions somewhat equivalent to those of the past.

Restoring or maintaining populations of sensitive species in the absence of management plans would have to be based on our best knowledge of the species. With these species, summarizing what is known about the biology of the species would be a beginning. The best activity for sensitive species with little or no biological data would be to monitor populations to learn more about them and to collect trend information.

Known populations of sensitive plant species should not be disturbed unless there is strong evidence the proposed activity would benefit the species and their populations long-term.

Although it would appear to be desirable to eliminate all introduced species, this condition is not practical to obtain. Some introduced botanical species may be beneficial in some ways, or neutral, and could remain without serious long-term effects to native species.

It would be desirable to greatly reduce or attempt to eliminate some recently introduced problem species while their populations are still small, such as yellow starthistle (*Centaurea solstitialis*). With this species an insect biological control is known and approved for release into thistle populations. The insects have been released in yellow starthistle populations in other watersheds on the Galice Ranger District and could be considered for this watershed as well. Other treatment possibilities are pulling, cutting, or covering with black plastic, depending on the population size and location. Currently, starthistle and scotch broom populations are being manually treated (hand pulled or cut) and monitored yearly.

Other species, such as bull thistle (*Cirsium vulgare*) and Canada thistle (*Cirsium arvense*), probably occur throughout the watershed in small populations. It would be desirable to treat concentrated populations of these species where they occur, but it is unlikely they could be eradicated altogether due to unknown individuals or small populations. Concentrations of these species could be pulled or covered with black plastic to reduce their occurrence.

The widespread establishment of Klamath weed, combined with its medicinal value, may inhibit the eradication of this noxious weed. Again, treatment possibilities include pulling, cutting, or covering with black plastic, depending on the population size and location. Biological control by introduced insects can be another method in keeping Klamath weed populations to background levels.

It is recommended that any heavy equipment to be used for restoration projects be cleansed of any loose soil and mud to greatly reduce the probability of transporting undesirable "weed" species to forest sites.

Native grass seed should be used for all restoration projects, however, it is unlikely that large amounts of native grass seed will become available for many years. An alternative to the lack of native grass seed would be to identify collection locations where large populations of native species are located and could be collected. Collected ripe seed heads could be spread at the desired restoration locations.

Any native or non-native species seed lots used for restoration within the watershed should be those that are certified containing no or minute amounts of "weed" species to prevent further introduction of undesirable plant species.

In order to advance the use of native grass species for restoration projects, it is recommended that some allocations of restoration funds be used for native grass seed work that would include collecting and sowing of native grass seed.

3.5.8 Known Sensitive Plant Species

- ***Arctostaphylos hispidula,* Howell's manzanita:** Dry rocky ridges and gravely soils, often on serpentine. Shrub communities or sparse forest, often growing with *A. columbia*.

- ***Bensoniella oregana*[2], Bensonia:** Relatively deep soils in moist meadows, and along streamsides, 3,000-5,000ft. Upper slope sites and ridge saddles with northerly aspects.

- ***Cupressus bakeri,* Baker's cypress:** Dry forested, brushy or open slopes, usually rocky ground or serpentine soils at 3,800-6,000ft.

- ***Encalypta bervicolla* ssp. *crumiana,* Snifter moss:** Found in relatively exposed, dry, montane, windswept sites; however, the microhabitat is generally protected by surrounding vegetation and overhangs, and is moister. On rock outcrops, in crevices and on ledges, wedged among stones or roots.

- ****Erigeron cervinus,* Siskiyou daisy:** Found in rocky places or crevices on solid rock.. Also open areas, medium to high elevations and sometimes in glaciated areas. Streambanks at lower elevations, usually near seeps or vernally wet spots.

- ***Eriogonum lobbii,* Lobb's buckwheat:** Gravely ridges and talus slopes at moderate to high elevations. Not generally found on serpentine soils.

[2] Riparian or wet area plants

- ***Frasera umpquaensis,* Umpqua green-gentian:** Open woods or at edges of meadows. In mid to upper elevation true fir dominated forests or mixed conifer forests (4,000-6,000ft.) generally in partial shade or openings.

- ***Fritillaria glauca,* Siskiyou fritillaria:** Gravely serpentine slopes and ridges.

- ***Hazardia whitneyi* var. *discoideus,* Whitney's haplopappus:** Rocky, open, coniferous forests slopes, 3,000-7,000ft.

- ****Iliamna latibracteata,* California globemallow:** Moist sites, streamsides in coniferous forests. Often in shady, disturbed ground. Elevation 200-2,500ft.

- ***Monardella purpurea,* Siskiyou monardella:** Rocky, open slopes on serpentine soils, 1,400-4,000ft.

- ***Triteleia hendersonii* var. *leachiae,* Leach's Brodiaea:** Wooded or open slopes, brush forest and meadow edges.

Terrestrial References

Agee, James K. 1997. Restoration of Blue Mountain Forests With Fire: Is It Possible? Blue Mountains Natural Resource Institute. Vol. 7 No. 3.

Atzet. 1997. Personal communication.

Bingham, B.B. and J.O. Sawyer Jr. 1991. Distinctive Features and Definitions of Young, Mature,, and Old-Growth Douglas-fir/hardwood Forests [in Northern California and Southern Oregon]. USDA. PNW-GTR-285.

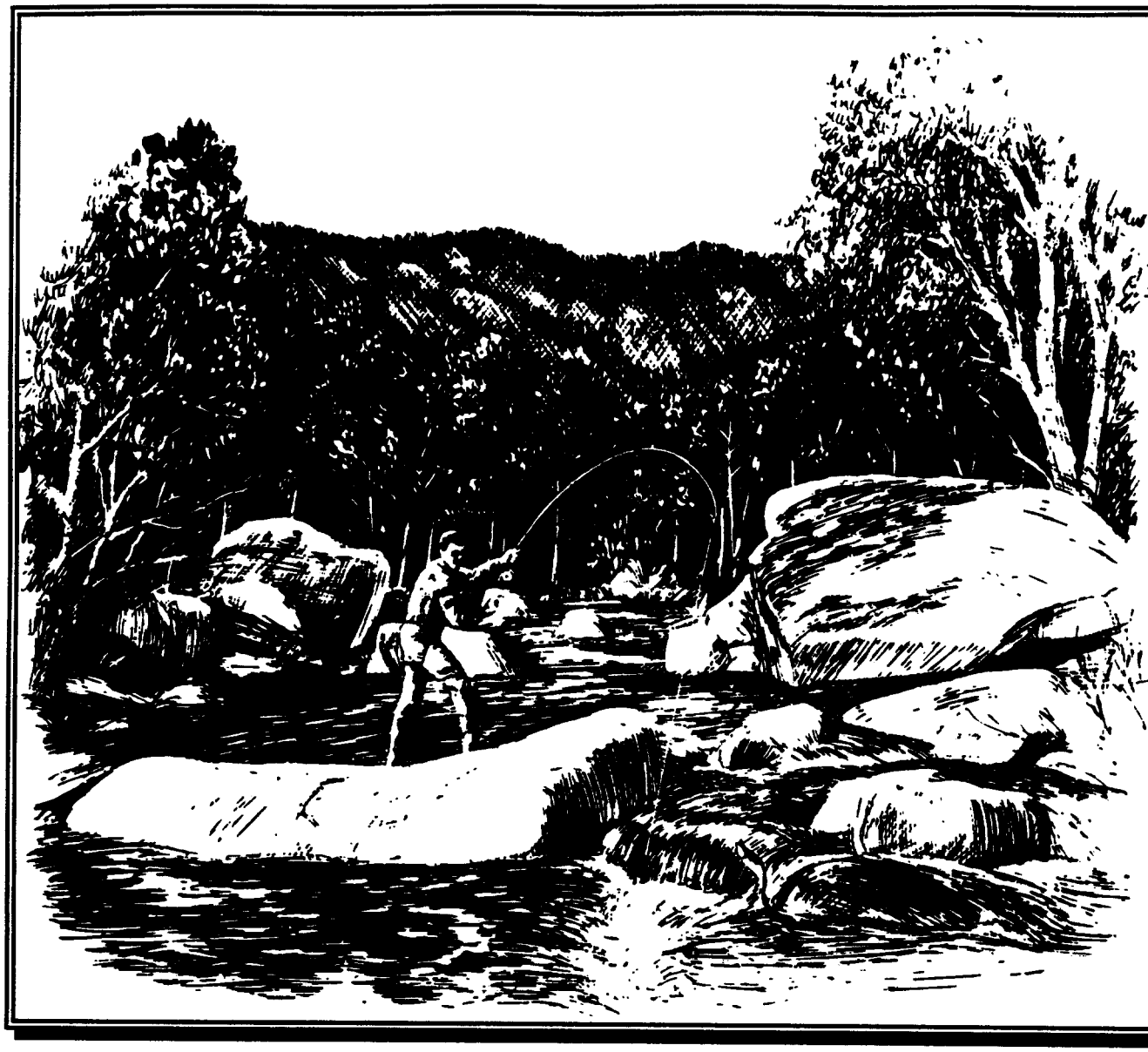
Brown et. al. 1985. Management of Fish and Wildlife Habitats of Western Oregon and Washington.

NW Plan. 1994. Northwest Forest Plan; Final Environmental Impact Statement, USDA Forest Service and USDI Bureau of Land Management. 1994

ROD. 1994. Record of Decision for Amendments to Forest Service and Bureau of Land Management Planning Documents Within the Range of the Northern Spotted Owl.

USDA, Forest Service, Siskiyou National Forest Land and Resource Management Plan. 1989.

INDIGO CREEK WATERSHED ANALYSIS



4.0 AQUATIC MODULE

Table Of Contents

4.1 AQUATIC ECOSYSTEM

4.1.1 Sediment Delivery

Landslides dominate the sediment delivery processes in the watershed. Inner gorges are common locations for debris slides, and debris flows initiate in the heads of stream channels. Rock fall occurs locally in the watershed, for example on the north slope of Sugarloaf Mountain (Henkle, 1990). Ancient landslide forms encompass entire hillslopes from ridge to channel (Landslide map from Silver Fire Recovery in process records). Deep soils are developed on deposits from historic or active deep-seated natural landslides. The large debris slide in the North Fork of Indigo Creek has progressively enlarged since the earliest aerial photographs, developing new scarps within the deep soils upslope (see details in Subwatershed section). Deep-seated landslide terrain has been mapped (USDA, 1979), but the history and current level of activity is not known for all of these areas (eg. very deep soils in East Fork). Potentially unstable sites should be suspected wherever deeper soils occur above inner gorges (Figures 1.1 and 1.2).

In 1964, an ancient landslide along West Fork Indigo Creek reactivated, damming the creek and forming an elongated lake. Boulder patches and long gravel bars are evidence that temporary lakes have formed behind landslide deposits in recent times, and during past glacial periods (USDA, 1994).

Many pre-1940 aerial photograph natural landslides are evident from an inventory of landslides within the area of the Silver Fire of 1987. A number of these older landslides exceeded one million cubic yards in volume. Within the inventory time period, the 1964 storm was the trigger for most of the landslide sediment delivery to streams in the Indigo watershed (Appendix D). The low volumes from road and harvest-related landslides reflect the limited development within the Silver Fire area (Figure 4.1).

Field reconnaissance traverses in the Lazy-Snail Project Area located 45 landslides, with all but eight naturally occurring (Henkle, 1990). Five harvest-related landslides (including three with an undetermined harvest or natural cause) delivered 18,000 cubic yards of sediment to stream channels. All roads were mapped, identifying three road-related slides for a total of 18,700 cy, but only 1,100 cy were delivered to stream channels. Natural landslides encountered during the traverse delivered approximately 5.9 million cy to streams (active within the last 50 years).

Although roads contribute a minor part of landslide sediment to stream channels in this watershed, many of these roads were not constructed at the time of the 1964 storm (Figure 4.1). Because these roads have not been tested by a major rain-on-snow event, the lack of road-related landslides should not be interpreted as a evidence of storm resistance.

Slopes that are most susceptible to landslides and severe surface erosion have been mapped for the Silver Fire area. These "Watershed Sensitivity" maps are available in the process records, but are not available for analysis within the Geographic Information System (data gap). Slope steepness is among the most important factors in landslide and erosion hazard.

Roads that traverse steeper terrain tend to have more problems with slides from road cutbanks and fillslopes. Channel erosion in steep stream channels can cause plugging of culverts and the consequences of plugged culverts that divert down the road are more serious. Roads on the steepest slopes and closest to streams are expected to have high sediment delivery potential (Appendix D). Fillslopes are generally more stable on roads constructed within the last two decades that include full bench excavation and removal of fill by end haul to waste areas.

The following road segments were identified from overlaying road locations with streams and slope maps. These are recommended for inventory of fill stability, drainage spacing, and diversion potential to determine if a landslide or erosion hazard actually exists. The consequences of sediment delivery will vary with the channel characteristics and whether the road is one of multiple roads on a stream channel (stacked). A map (in the process

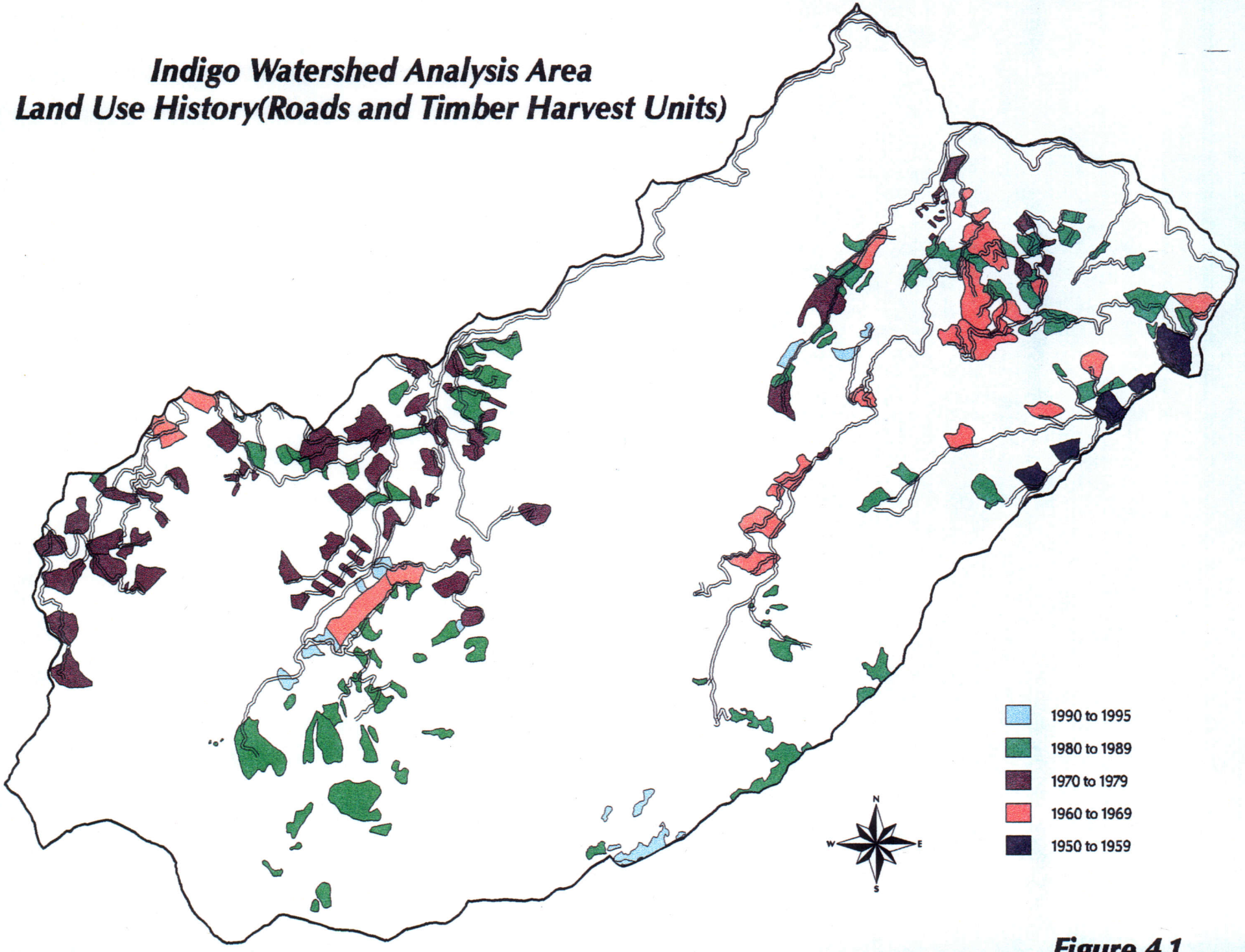

Indigo Watershed Analysis Area
Land Use History(Roads and Timber Harvest Units)
1990 to 1995
1980 to 1989
1970 to 1979
1960 to 1969
1950 to 1959
N
W
E
S

Figure 4.1

records) identifies both stacked road segments and the steep segments.

East Fork - has a higher road density than other subwatersheds, and a higher proportion of roads on steep slopes.

Upper East Fork

- 2411021 in section 33
- 2411052 in NE section 33 and SE section 28
- 2300412 at end of road
- 2300 Bear Camp Road in head of unnamed tributary - low delivery potential?

Buck Creek in Chief Creek:

- 2300416 sideslopes at crossing

East Fork above Breezy:

- 2300055 NE section 36

Breezy Creek:

- 2411099 to Hobson Horn and 2411 east of the junction with 2411099.

West Fork

Slim Creek

- 2308 Burnt Ridge Road in headwaters - long runout potential?

Upper West Fork below Slim Creek

- 2300440- steep, crosses small streams
- Snail Basin has a high road density, but low proportions of roads are on steep slopes.
- 2308076 to Sugarloaf Mountain crosses the west side of the steep-walled cirque basin.
- 2308 Burnt Ridge Road - steep northeastern most segment
- Lower West Fork: 2300056 - many segments with delivery potential

North Fork - some parts with high road density, but a low proportion of roads are on steep slopes

- 3577 spur road off to southwest at 3577260 junction, and segment on 3577260
- 3577060 spur road to top Raspberry Mountain - steep but low delivery potential?

Mainstem Indigo - area west and northwest of Fish Hook Peak has high road density, but a low proportion of roads on steep slopes

- 2308154 and spur upslope (SE section 7) cross headwaters with stacked road system

Road-Related Erosion: The relative rate of sediment delivery from road-related erosion has not been measured in the Indigo Watershed (data gap). Measurements in Shasta Costa Creek along roads within similar slopes, elevations, and rock and soil types have documented high volumes of erosion at road drainage outlets (Park, Ricks, Risley, et.al field notes).

Erosion from Silver Fire: Some intensely burned sideslopes adjacent to the East Fork of Indigo Creek have lost soils by ravel erosion. Rapid revegetation after the Silver Fire has slowed this process.

4.1.2 Large Wood Supply

The supply of large wood to channels in the watershed is generally much greater from north-facing slopes (Figure 4.2 - PMR data 1988). The Silver Fire of 1987 covered approximately 37% of the watershed, and riparian vegetation was affected in the upper tributaries and mainstem of East Fork Indigo Creek. The wood supply may be naturally limited in the upper East Fork by less productive shallow soils (Figure 1.2), and on steep slopes where trees have been scoured by natural debris flows (Figure 1.1). Debris flow source areas at the heads of channels are critical to include within Riparian Reserves to protect the supply of large wood. The areas most likely to deliver large wood by landslides are shown as high sensitivity for those areas that have a completed watershed sensitivity map (see References and Process Records). Riparian vegetation was scoured from the 1964 flood and associated landslide along West Fork Indigo Creek (see Channel Morphology section).

The North Fork Indigo Subwatershed has the highest proportion of riparian vegetation classified as late seral structural/size, 39%, and as mid seral, 23% (Appendix D). Much of the 17% pioneer vegetation was converted from late seral by harvesting along small streams in the 1970's (Figure 4.1). The highest proportion of riparian vegetation classified as early seral is in the West Fork Indigo Subwatershed, 31%. The East Fork Indigo Subwatershed has the highest proportion of pioneer riparian vegetation, 27% (see Terrestrial Module: Fire).

Roads can intercept debris flows and cause deposition of large wood that could have been delivered to the channel. In this watershed, few roads are located in midslope or toe slope positions

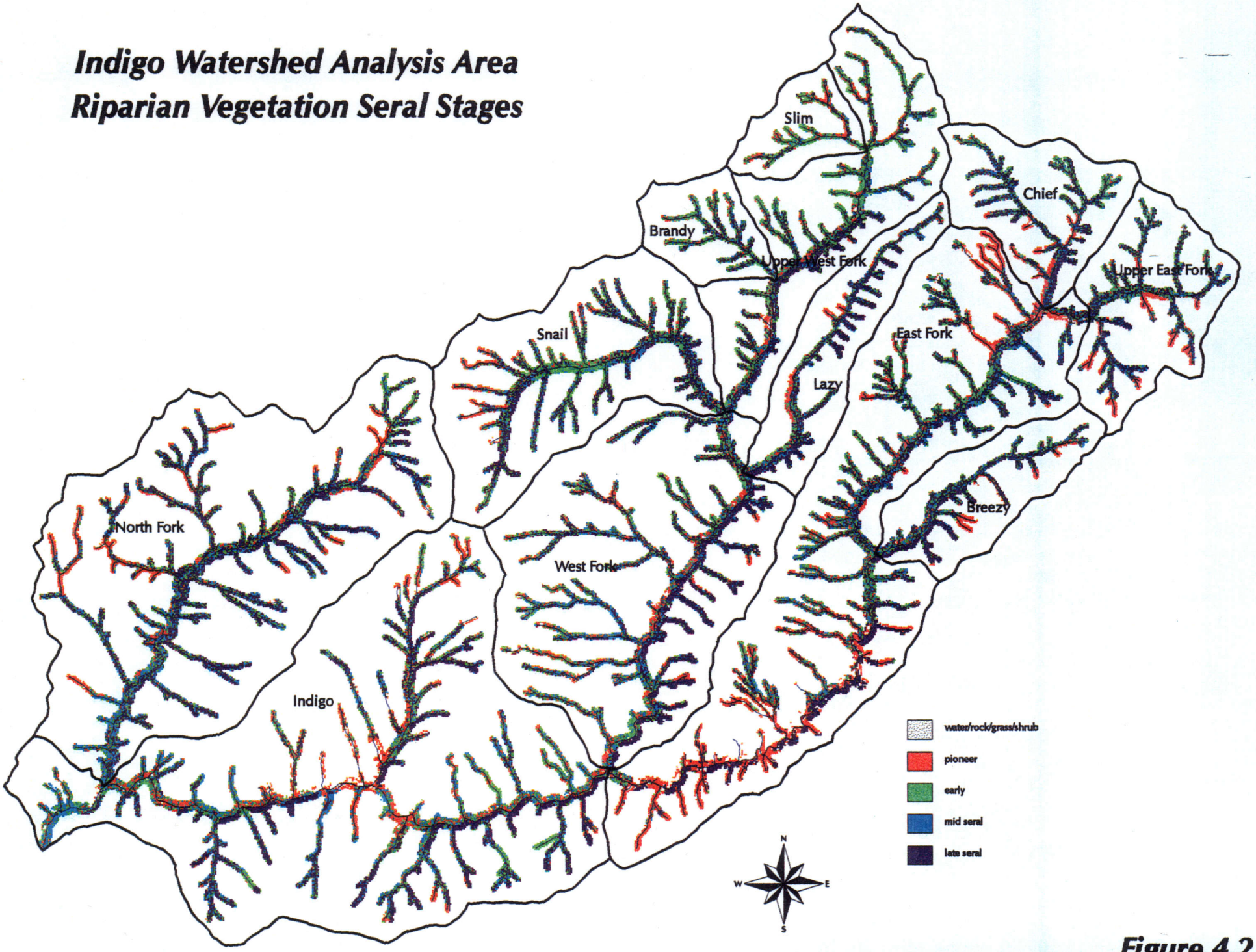

Indigo Watershed Analysis Area
Riparian Vegetation Seral Stages
Slim
Chief
Brandy
Upper West Fork
Upper East Fork
Snail
East Fork
Lazy
Breezy
North Fork
West Fork
Indigo
water/rock/grass/shrub
pioneer
early
mid seral
late seral
N
W
E
S

Figure 4.2

on steep terrain, so roads should have a minor effect on wood delivery.

Wood and sediment deliver to fish bearing stream segments down adjacent stream channels in bedrock valley segments of Indigo Creek (debris flows) and via landslides where colluvial slopes adjacent to the stream channel fail. See the hydrology section for a broad characterization of the valley types in the watershed.

Currently there are two natural active landslide features in the watershed. There is a natural landslide dam on West Fork Indigo. It has created a 400-foot long pond disturbance with water up to 18 feet in depth. An active landslide and debris chute is located in the North Fork Indigo sub-watershed. It is responsible for chronic increased turbidity and fines in North Fork and the mainstem Indigo below North Fork.

4.2 CHANNEL MORPHOLOGY AND WATER QUALITY

4.2.1 Channel Morphology

Stream width and channel alignment is generally limited by the inner canyon gorge. Inner gorge landslides influence channel morphology. The channel substrate is primarily bedrock with large cobbles and gravels and occasionally large boulders. Large wood is scarce in the mainstem of Indigo Creek.

TABLE 4.1
RIPARIAN RESERVE ACREAGE AND STREAM MILES

	Stream Miles	Riparian Reserve Acres[1]
Fish Bearing	50	4,153
Perennial	203	7,737
Intermittent [2]	267	11,262

1) Riparian reserve width is based on average site potential tree equaling 174 feet in height in accordance with the AQS objectives.
2) Based on Silver Basin relationship for perennial /intermittent streams, Silver Watershed Analysis, 1995.

The storm of 1955 was the first major storm to hit the southern Oregon coast in decades. Several watersheds up and down the coast such as Shasta Costa, a neighboring watershed and Elk River near Port Orford experienced severe disturbance to the channel and riparian area. There was no evidence of any flood damage from this storm in Indigo Creek.

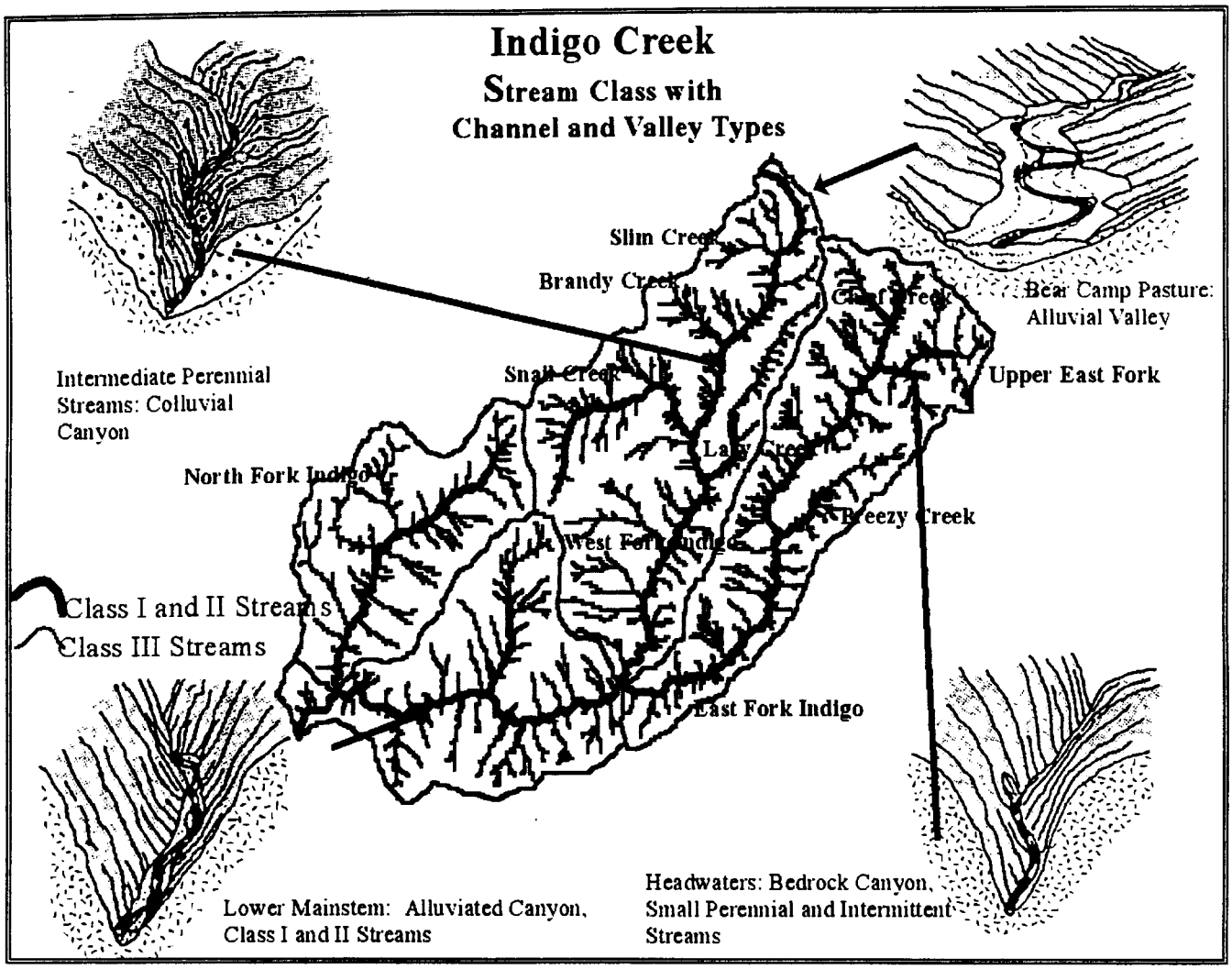
The 1964 storm delivered heavy rains and caused rapid snow melt, causing widespread impacts to higher elevation watersheds. The storm triggered a large natural landslide on the West Fork in an area that previously failed sometime prior to 1940. Debris from the slide scoured the channel, removed riparian vegetation, and triggered more stream bank failures downstream.

The added debris from downstream failures continued to fuel the force of the landslide causing impacts to the entire mainstem below the slide. Transport reaches were scoured and large deposits formed in depositional reaches. All of the remaining channels in the watershed were unchanged by the storm event. The impacts to the mainstem are attributed to the landslide, not high flood water from the 1964 storm.

On August 30, 1987, lightning ignited a fire in both the Silver Creek and Indigo Creek watersheds. Approximately 37% of the Indigo Creek drainage burned. The up slope and riparian areas of the mainstem East Fork were severely burned. Photo interpretive work revealed sediment delivered from the burned area over the following years caused the mainstem to aggrade, becoming wider and more shallow. The fire had little effect on the remaining channels in the watershed.

A storm in 1995 reactivated the chronic North Fork Slide. It is estimated that 220,000 cubic yards of material was delivered to the stream. Water quality on the Illinois River and the Rogue River was severely impacted for several days. The effect to the North Fork and Indigo below NF channels was aggradation in depositional reaches.

Management activities including timber harvest and road construction have had little, beyond locally, effect on the mainstem stream channel; see subwatershed section for exceptions. The Indigo watershed's history of natural disturbance has played a key role in forming the mainstem channel and its present condition.



4.2.2 Water Quality

Water Quality parameters included stream flow, temperature, turbidity, and water chemistry. Both natural processes and human activity have effected water quality.

Human activities that can affect water quality are timber harvest and road construction. Timber harvest and road construction began in 1958. Since then, approximately 12% of the watershed has been harvested. Timber harvest is not expected to continue in this watershed because it is almost entirely within Late Successional Reserve. There are currently 133 miles of road in the watershed with approximately 10 miles of them located in riparian reserves. There is no known current mining activity or domestic water use in this watershed. Historically there has been prospecting throughout the watershed, but there is no detailed history of past mining or water rights.

4.2.3 Stream Flow

Droughts and floods change the magnitude and frequency of stream flow. Southern Oregon was in a drought cycle during 1985-1994. Lower than average stream flows were recorded in Siskiyou National Forest prior to 1995. The following years included major storms events and greater than average rainfall years resulting in higher than average summer and winter streamflows.

Low flows during the drought of 1992 were less than half the amount recorded at same locations during the average rain fall year of 1993. Currently Indigo Creek near the mouth has a range of low flows of 13-37 cfs. From 1958-1967 the range was 16-25 cfs. Climatic variation and vegetation

changes due to fire suppression and catastrophic events including the 1987 Silver Fire, may contribute to the current ranges of streamflow.

Increases in subwateshed water yield (low and peak flows) may be associated with management activity. Road surfaces and cut slopes intercept water, and road ditches act as intermittent streams, transporting water more rapidly than natural processes. These properties of roads combine to change the timing and increase the size of peak flows. The potential for effects from increased peak flows is the greatest in areas where road density is highest and when they are located in riparian areas.

4.2.4 Stream Temperature

Stream temperature is a function of several factors including solar intensity, weather, stream flow, and the amount of stream surface area exposed to solar radiation. Fire, large storms and human activities such as timber harvest and road construction have the potential to influence stream temperature by altering channel shapes and amount of shade-producing vegetation.

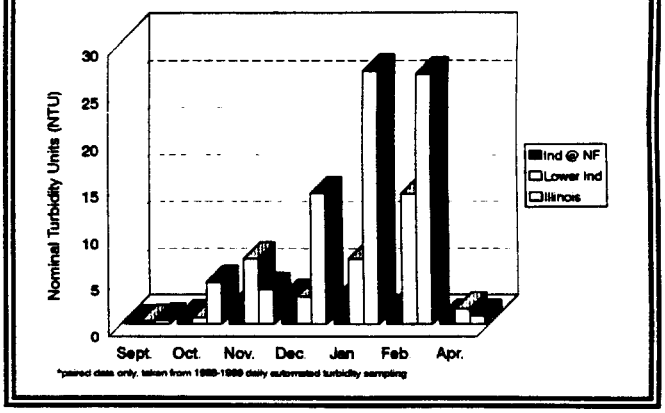
Natural disturbance in the Indigo watershed has played a key role in defining the range of natural variability of historical stream temperature. Stream temperature most likely increased following the 1964 flood, when much of the mainstem riparian vegetation was lost and the stream channel was widened. Subsequent recovery of vegetation has cooled stream temperature.

Timber harvest in the small headwater intermittent streams has probably had little or no effect on increasing stream temperature on the mainstem. It was expected that as a result of the Silver Fire, which burned riparian vegetation particularly in the East Fork Indigo sub-watershed, stream temperatures would increase due to the loss of stream shade. However, stream temperature monitoring has shown that water temperature has not appreciably increased, but has found a decreasing trend. The summer seven day average high stream temperature range is 69-73 degrees F on the mainstem (Table 4.3).

4.2.5 Turbidity

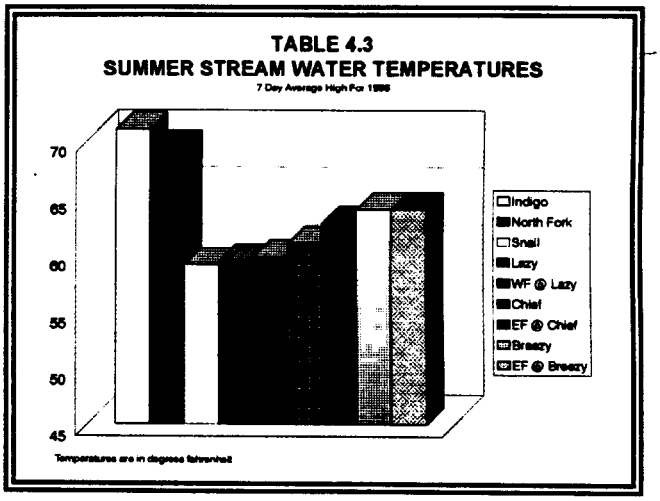
Turbidity, or the loss of water clarity, is due to the presence of suspended particles of silt and clay, but other materials such as finely divided organic matter can contribute to the loss of water clarity. Potential sources of sediment in the headwaters of Indigo Creek include disturbed soils associated with timber harvest and roads. Average winter turbidity on the mainstem of Indigo above NF Indigo are low and range form 1-3 NTU (nephelometric Turbidity Units) during non-storm periods. NTU refers to nephelometric turbidity units, a unit measured by a photoelectric turbidimeter.

FIGURE 4.2
AVERAGE WINTER TURBIDITY



The above bar graph of turbidity, Figure 4.2, shows the monthly averages of turbidity. Turbidity does not appear to be a significant area of concern. Winter storms increase turbidity, which is normally expected.

TABLE 4.3
SUMMER STREAM WATER TEMPERATURES



Natural landslides have greatly increased turbidity at periodic times in the past. The large landslide on the West Fork, which was triggered by the 1964

storm, is one example. Most recently, the chronic slide on the North Fork severely increased turbidity on Indigo Creek, Illinois River and the Rogue River, see geology section.

4.2.6 Water Chemistry

Sulfate, Alkalinity, and specific conductivity levels in the watershed all have ranges indicating high water quality. Refer to Table 4.2 for specific water quality values.

TABLE 4.2
INDIGO WATERSHED WATER QUALITY
(Data Set From 1990)

Watershed	pH	Specific CO	Alkalinity	Sulfate
Indigo	7.5	105	44	6.55
West Fork	7.45	90	36	4.72
East Fork	7.93	120	38	4.23
Snail	7.75	10	37	5.28
Lazy	7.35	80	32	2.32

4.3 FISHERIES

4.3.1 Introduction

Indigo Creek watershed contains the following fish species: fall chinook salmon, winter steelhead trout, resident and searun cutthroat, rainbow trout and sculpin. Steelhead/rainbow trout are the dominant salmonid species in this watershed. About 20-25 miles of stream habitat in Indigo Creek are accessible to steelhead, varying with streamflow and changes in the stream channels of the watershed. Approximately an additional 7-10 miles of streams in the watershed contains resident cutthroat and rainbow trout populations. Rainbow and cutthroat trout can contribute to anadromous populations by migrating to the ocean from above and below apparent migration barriers. Indigo Creek is a key watershed in the Northwest Forest Plan.

Chinook salmon, although occasionally observed in this watershed, are usually sparse in numbers. The flashy flow regime of this steeply-dissected watershed and frequent bedload changes, render Indigo Creek somewhat inhospitable to fish that spawn in the fall before most winter storms. No hatchery introductions are on record for Indigo Creek, all fish are presumed to be of wild origin. Together with Silver Creek to the south, these two key watersheds are the mainstay of steelhead habitat in the lower Illinois River and represent a very significant genetic core for the steelhead population of the Illinois River and the Rogue River Basin (ODFW, personal communication). See Indigo Creek

Indigo Creek watershed represents about 8% of the watershed of the Illinois River, but the capability of this watershed for steelhead spawning and rearing is disproportionately high. About 23 miles of Indigo Creek and tributaries have been surveyed with the results shown in Table 4.4. These surveys cover most of the stream habitat accessible to winter steelhead and some of the resident trout habitat in upper reaches of tributaries. Most of Indigo Creek is inaccessible and difficult to access for yearly monitoring.

The concentration of road development and timber harvest on potentially unstable terrain, particularly the North Fork and East Fork, raises concern for protection of the valuable steelhead and trout populations in Indigo Creek.

4.3.2 Contribution to Illinois River and Sport Fishery

Indigo Creek and tributaries constitute significant steelhead spawning and rearing habitat in the Illinois River and contribute to the Rogue River sport fishery below the confluence with the Rogue River at river mile 26. The Rogue River is world-famous for its salmon and steelhead fishing, winter steelhead fishing is very popular in this lower Rogue River segment below the Illinois River. Thousands of fishing days are spent here in pursuit of chinook salmon, steelhead and trout. Public interest in the conservation of watersheds, salmon and other fish populations is increasing.

Indigo Creek and the Illinois River steelhead in general exhibit a life history more typical of coastal winter steelhead; two years in freshwater habitat and two years rearing in the Pacific Ocean. Illinois River winter steelhead tend to be larger in size than upriver fish, because few exhibit the half-pounder life history more typical of middle and upper Rogue River summer and winter steelhead.

Mainstem Indigo Creek - Photos from 1995 Stream Survey

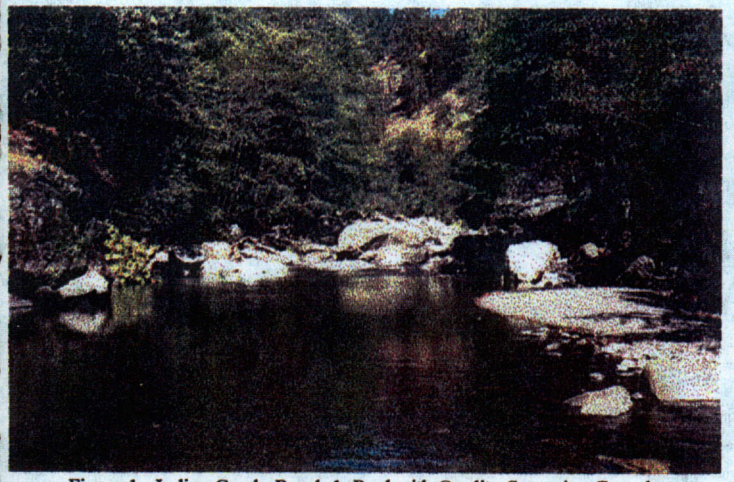
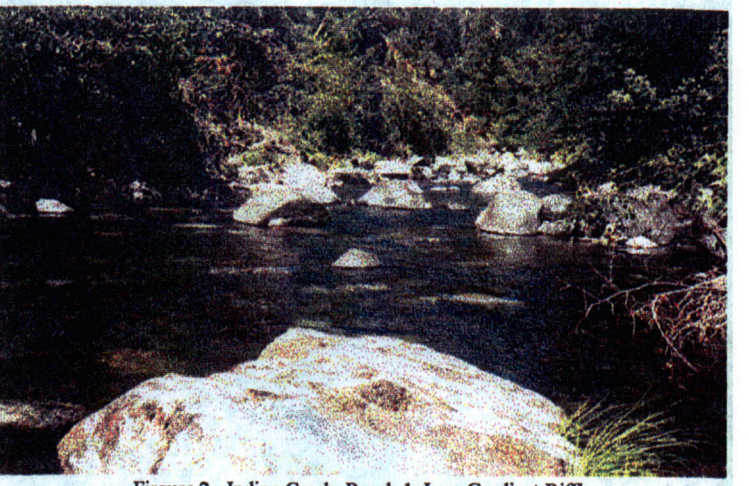


Figure 1 - Indigo Creek, Reach 1, Pool with Quality Spawning Gravels



Firgure 2 - Indigo Creek, Reach 1, Low Gradient Riffle

Figure 3 - Indigo Creek, Reach 2, Pool Hhabitat at Beginning of Reach

Figure 4 - Indigo Creek, Reach 2, Typical Low Gradient Riffle in Reach

Figure 5 - Indigo Creek, Reach 3, Confined Canyon with Boulders

Figure 6- Indigo Creek, Reach 4, Rapids Typical of Reach

TABLE 4.3
STREAM WATER TEMPERATURES

	1988	1989	1990	1991	1992	1993	1995	1996
Illinois River	76.2	71.8	73					
Indigo	70.4	69.9	72.7					70.9
NF Indigo							69.3	66.7
EF@ Breezy						60.6		63.9
EF@ Chief						59.3	60.7	62.7
Breezy						60.6	63.9	
Chief						58.6	60.9	59.5
WF@ Lazy				59.2	60.2			59.7
Lazy				57.1				59.3
Snail				57.8	59.7			59

TABLE 4.4
INDIGO CREEK WATERSHED INSTREAM HABITAT TABLE

Year of Survey & Stream Name	Reach Number	Ave. Reach Gradient	Reach Length	Ave. Wetted Width	Expected Pools Per Mile	Pools Per Mile	Large Wood Per Mile	% of Surface Area of Habitat in Pools
95 Indigo	1	3	3,890	31	24	22	1	30
8.1 miles	2	1	8,346	31	25	15	3	66
	3	2	22,469	32	24	24	13	56
	4	3	9,701	30	25	25	5	53
90 Indigo	1	3	3,819	35		8	5	18
	2	1	6,230	32		29	14	60
	3	2	21,648	32		11	11	42
	4	4	10,560	36		17	17	53
92 Breezy	1	15	4,512	11	69	18	59	6
1.3 miles	2	22	2,197	9	86	14	26	6
91 Snail Ck.	1	1	3,246	19	39	33	80	44
3.6 miles	2	4	3,257	17	45	49	91	38
	3	4	7,490	16	48	30	71	24
	4	7	4,976	14	53	34	56	25
91 Brandy Ck.	1	11	1,251	11	72	63	42	34
0.2 miles								
94 Indigo EF	1	3	11,306	28	27	33	7	35
3.3 miles	2	1	6,235	27	28	28	10	57
94 Indigo WF	1	2	7,842	27	28	26	14	49
3.2 miles	2	2	3,204	33	23	33	25	36
	3	2	5,630	33	23	18	28	23
92 E. Fork Indigo	3	4	13,026	21	36	18	11	29
5.9 miles	4	3	8,355	25	30	20	13	19
	5	2	14,407	21	35	12	27	12
	6	4	7,080	13	59	25	70	16
91 W. Fork Indigo	4	5	6,322	19	40	23	119	28
2.9 miles	5	10	7,632	13	59	20	55	17
	6	4	1,588	9	85	23	27	15

NOTES: All length and width measurements are in feet. 1990 Indigo survey lumps glides with pools and includes estimate of pocket pools in cascades for this number.

4.3.3 Habitat Conditions and Disturbance Agents

Indigo Creek has extraordinary value as a winter steelhead spawning and rearing watershed. Surveyor Steve Trask, who has considerable experience surveying Oregon streams, stated in the his 1995 survey report that the numbers of juvenile steelhead rearing in mainstem Indigo Creek were among the highest he had witnessed in his career. The durability of the bedrock canyon landform coupled with the durability of steelhead trout to thrive in high energy streams makes for a highly productive situation for steelhead, rainbow trout and cutthroat trout. Indigo Creek does not contain alluvial valley habitat and backwaters to provide quality salmon overwintering habitat. Water quality and habitat are good for steelhead:

- moderate summer and winter water temperatures[1].
- adequate spawning gravels,
- plentiful pool habitat with good depth, and
- boulder cascades and riffles with plentiful interspaces and pocket pools for refuge from high flows and predators.

Large wood does not play a large role in forming instream habitat components in mainstem Indigo Creek and the larger tributaries. Wood is present in occasional complexes and is integral in bar and terrace formation in some stream segments. Large wood does not exist in great quantities in mainstem Indigo Creek or the larger tributaries. On the eastside of the Siskiyou Mountains stream survey data indicate an average of about 25 large pieces per mile (>24 inches minimum diameter and 50 feet long) while on the westside wood numbers can be as high as 50 pieces per mile. These piece per mile data is within the natural range for streams on the east and westside of the Forest. Mainstream Indigo Creek has from 1 ½ to 13 pieces per mile and the East Fork has from 7 ½ to 10 pieces. The West Fork of Indigo Creek appears to be more representative of wood levels for the Siskiyou Mountains outside of serpentine geology with 14 to 28 pieces per mile.

1 Indigo Creek is listed as water quality limited by the Oregon Department of Environmental Quality because the seven day average maximum temperature exceeds sixty-four (64) degrees Fahrenheit during the summer months. Warm summer temperatures are common in similarly sized streams in Siskiyou Mtn. geology.

The West Fork appears to be less influenced by timber harvest, roads and the 1987 Silver Fire.

The West Fork of Indigo Creek is considered a very important for subwatershed for the production of winter steelhead in the Illinois River sub-basin. Sediment in Snail Creek and West Fork disconnects habitat during the summer months as flows are sub-surface. Previous analysis suggests that additional sediment inputs to Snail Creek and West Fork may lessen the season of passage for adult and juvenile trout and steelhead in this productive sub-watershed (West Indigo EIS). Landslide materials, probably natural, in both Snail Creek and West Fork Indigo Creek limit and block use of upstream habitat suitable for steelhead.

A principal fisheries objective of this watershed analysis is to identify and plan for closure of road segments that degrade aquatic and riparian habitat. Though the watershed is durable, closing roads will allow for more historic levels of sediment delivery and streamflow.

The evolution of the stream channel in Indigo Creek has been influenced by wildfire. In fact, evolution interspersed with "revolutionary" periods of extensive fires and subsequent winter storms causing major channel changes is a more appropriate scenario for this watershed. Approximately 12% of the watershed has been harvested and the 1987 Silver Fire burned about 37% of the watershed.

Smaller tributaries such as Snail Creek, Breezy Creek and Brandy Creek are more able to hold wood boles and have larger amounts of large organic material. Table 4.3 displays the relative abundance of wood in these channels; stream surveys done before 1994 probably overestimated the size of large wood due to less frequent quality control. These stream systems seem to hold wood in temporary complexes at narrow points in the channel and high on terraces. Rarely does large wood remain in the wetted channel for extended periods. It is important that delivery-prone areas be considered riparian reserves areas because of the integral roles of structure and storage that wood provides to Indigo Creek stream channels.

TABLE 4.4
SALMONID DENSITIES IN MAINSTEM INDIGO CREEK

Stream Reach	Young Of The Year Steelhead & Rainbow Per Square Yard	1+ Age Class Steelhead & Rainbow Per Square Yard
Reach 1 - 0.73 miles	0.06 fish	0.05 fish
Reach 2 - 1.58 miles	0.03 fish	0.02 fish
Reach 3 - 4.26 miles	0.10 fish	0.06 fish
Reach 4 - 1.84 miles	0.23 fish	0.13fish

Densities of steelhead/rainbow in Reaches 3 and 4 are good, particularly for older age class steelhead/rainbow. These reaches total 6.1 miles of prime steelhead rearing habitat. An average of 1,069 per mile young-of-the-year and 606 per mile of 1+ age steelhead/rainbow reside in these two reaches when sub-sample data is extrapolated to the entire reach. Reach 2 is important for spawning habitat because of abundant gravel, but does not have the boulder complexity necessary for rearing high densities of juvenile steelhead. Reach 1 is most downstream in the system, susceptible to extreme winter freshets, has higher summer water temperatures and is less complex that upstream reaches.

4.3.4 Comparison of Historic and Current Conditions

Indigo Creek has experienced a wide range of channel conditions in the recent past. Drought, fire and intensive winter storms have resulted in a wide range of conditions in the large tributaries and the mainstem. It is difficult to catalog the conditions of a powerful watershed such as Indigo Creek as outside of its natural range of variability. This range of conditions has been extremely wide with the ebb and flow of disturbance agent occurrences, primarily fire and intense winter storms. These two phenomena associated in time, stand replacement fire and intensive winter storms, cause major channel and riparian changes in a relatively short time. Steelheads, with their ability to flourish in steeper gradient riffle habitat and cobble/boulder environments, have flourished in Indigo Creek where salmon have not. In periods of less winter storm intensity chinook salmon may be present in higher numbers, spawning and rearing in reaches 1 and 2.

4.4 BIOTIC COMPONENTS MACROINVERTEBRATES

The objective in collecting macroinvertebrate samples within the Indigo Creek basin was to establish baseline information on macroinvertebrate communities and monitor the effects of past land management activities at a watershed scale.

Aquatic insects are very successful in freshwater environments. Their diversity and abundance, broad distribution, and their ability to exploit most types of aquatic habitats demonstrate this. Some species have adapted to very restricted environments and the life cycle is used to provide a framework for describing different ways that insects cope with the challenges presented by aquatic habitats. Factors that can influence utilization of a particular habitat can be grouped into four broad categories: (1) physiological constraints (e.g., oxygen acquisition, osmoregulation, temperature effects); (2) trophic considerations (e.g., food acquisition); (3) physical constraints (e.g., coping with habitat); and (4) biotic interactions (e.g., predation, competition) (Wallace 1996).

Benthic invertebrate biomonitoring is used as a survey tool to screen watersheds. Watersheds of interest, identified by the screening process, can then be evaluated on an annual or semiannual basis to determine if the invertebrate community is experiencing recovery, deteriorating, or remaining static. Because aquatic macroinvertebrate community structure changes dramatically in response to changes in habitat (temperature, sediment, water chemistry, flow) it is an effective tool in detecting environmental change over time. This is due to their extended residency period in streams. They are relatively immobile and cannot avoid "events" or "pulses" of pollutants or other forms of stress often missed by conventional water or habitat quality sampling. Presence or absence of specific taxa can be indicative of specific environmental and habitat factors. Aquatic insects are a direct and definitive measure of biotic

integrity. They can be used as a barometer of overall biodiversity in aquatic ecosystems. Most important, aquatic insects are the primary food source for many stream fish.

Eleven benthic macroinvertebrate samples were collected from Indigo Creek Watershed, see Appendix B, during the month of October from 1988 to 1995. [Biological assessments were completed by Fred A. Mangum, Regional Aquatic Ecologist, Intermountain Region-USDA Forest Service, (1988-1990 samples); Bob Wisseman, Aquatic Biology Associates, Inc. (1990-1992 samples); and Cascades Environmental Services, Inc. (1995 samples).]

4.5 SUBWATERSHEDS

The main tributaries to Indigo Creek are North, West, and East Forks. Smaller named tributaries to West and East Fork are Snail, Lazy, Brandy, Slim, Breezy, Chief, and Buck Creeks.

Mainstem Indigo Creek is divided into four distinct stream reaches as shown in Table 4.4. Stream Reaches 1 (0.73 miles), 3 (4.26 miles) and 4 (1.84 miles) are boulder dominated channels with abundant deep pools. These reaches have a large capacity for rearing juvenile steelhead and some adult rainbow trout with boulder interspaces and pocket pools providing complex rearing niches. Although relatively low gradient (2-3%), confinement and stream power provide for transportational qualities with mostly cobble and boulder streambed properties. Reach 2 (1.58 miles) has a gradient of 1% and is more depositional in character. This reach is less transportational, more pool/riffle in nature than the other reaches and is as close to a response reach as you find in this powerful stream system in mainstem Indigo Creek. Pools are abundant, more than 30% of wetted habitat area in all reaches, and quite deep throughout the mainstem with residual depths of 3-5 feet and some pools 10 feet in depth.

4.5.1 Lower Indigo Creek

This segment for analysis purposes, is 10,793 acres in size, and is the lower 8.1 miles of westerly flowing mainstem from the East and West Fork confluence downstream to the mouth where it joins with the Illinois River. Indigo Creek is a 6th order stream in this reach. The inner gorges of the canyon in this sub-watershed are bedrock slots, 50-200 feet wide and several hundred feet high. They confine and define the stream. Terraces exist along the canyon bottom here, but are rare. Some are elevated 20 to 100 feet above the stream; deposits or remnants of former streambed waiting to be moved by future peak flows. Large wood does not a play a large part in pool formation and is almost non-existent in this reach, found occasionally in logjams between bedrock crevices, large boulders, or on high terraces. Much of this portion of the canyon is wall to wall stream during peak flows with stream gradients averaging 3-4 percent. Pools are deep (depths recorded over 30 feet) and are formed by cascades over bedrock drops and falls. This stream segment is near historic condition regarding in stream large wood, and for factors that drive its shade/stream temperature aspects of morphology.

Indian Flat, a high meadow riparian terrace, is a unique feature immediately downstream of North Fork. It is privately owned and is currently in excellent condition regarding stability and its integrity as a feature. The stream section from North Fork downstream to the mouth is subject to riparian vegetation removal from storm events. The storms of 1995 and 1996 removed large amounts of streamside vegetation in this stretch. The North Fork slide has also deposited a few thousand yards of fine sediments in the lower gradient stretches of this reach (see North Fork section).

There is a ¾ mile long, low gradient, "critical reach 6" located 1 mile above the mouth. Cross sectional monitoring of this reach during the years of 1988-1990 show that the stream was in equilibrium regarding its ability to transport sediment for the years in observation. Although the monitoring followed the catastrophic event of the Silver Fire, it should be noted that there were no storms of magnitude which would have been expected to trigger sediment producing landslides during those years.

4.5.2 North Fork

North Fork confluence is located 1.5 miles above the mouth of Indigo Creek and flows southwesterly in orientation. A unique feature in North Fork is a large slide and debris chute seen first in aerial photographs taken in 1940. This is a natural occurrence away from roads and harvest units. It

has delivered approximately 220,000 cubic yards of sediment since that discovery. This sediment is clay rich and will suspend easily causing visual turbidity that has been reported during the last two years by the public and USFS employees. The 1988-1990 automated water sampling data indicate the presence of higher turbidities when compared to the mainstem of Indigo. The source of turbidity has been determined to be the North Fork slide. There are no recommendations for the chronic failure that is predicted to produce shallow failures and resulting turbid waters every 5-10 years.

An historic inventory and field survey was completed for the "North Fork Indigo Slide", but not for the entire subwatershed (data gap). The large natural debris slide in North Fork Indigo has moved periodically since before the earliest aerial photographs in 1940. Later photos indicate that the landslide had increased in size, mostly between 1956 and 1964, delivering an estimated total of 100,000 cubic yards as of 1986 (USDA, 1990). Turbid water from the North Fork Indigo had been observed at the mouth of the Illinois River periodically, including the winter of 1982. On 1986 photos, a scarp encompassing approximately 4.6 acres was evident; this was the block that detached and delivered a large proportion of an estimated 120,000 cubic yards in April, 1996.

4.5.3 West Fork

West Fork confluence with East Fork is located 8.1 miles above the mouth of Indigo Creek and flows south in orientation. A unique feature in West Fork is the presence of large alluvial terraces or benches adjacent to the current stream channel. These terraces have fair amounts of Old Growth size timber. Stream side riparian vegetation has been affected by storm events. Aerial photographic study indicate that there is riparian recovery from past storm events including the 1964 storm.

On the West Fork, 6.8 miles upstream, a landslide blocks fish migration. This feature was formed when an ancient landslide reactivated from the 1964 storm and flood. It delivered sediment that affected approximately a mile of stream channel and formed a dam that ponded water for about 1000 feet upstream (USDA, 1994). The current "West Indigo Lake" is 400 feet long and 20 feet in depth.

The landslide is also responsible for the intermittent stream flow condition during low flows as active stream flow is interrupted by slide debris which forces flows to move subterranean, then to resurface several meters downstream. The scenario is repeated in several locations for approximately one mile. The interchange between surface and ground water through this stream segment is expected to lower surface water temperatures downstream from the site.

4.5.4 Lazy Creek

Lazy Creek confluence is located 5 miles above East Fork and West Fork Indigo confluence. Mountain slopes confine the channel. Pool formation and channel stability in this stream is highly dependent on large wood. Large wood often causes logjams, waterfalls and plunge pools. Spawning sized gravels are concentrated in and around the logjams. Short-term micro sites of streamside soils and young vegetation are found around these sites as well. Stream banks are generally stable and are well armored by riparian vegetation. The stream is primarily intermittently flowing from its headwaters to a point approximately ½ mile above the mouth.

There has been no recent fire or other natural catastrophe in this sub-basin. Therefore there may be a higher than normal abundance of fuels in the headwater areas of this sub-watershed.

4.5.5 Snail Creek

A migration barrier is present from a landslide at stream mile 1.4 (USDA, 1994). Boulders were delivered to the channel from an active debris slide at the margin of a large slump. Located at a right angle turn of Snail Creek, the toe of an oversteepened slope was undercut to produce a large inactive slump, possibly during a past glacial period when Snail Creek was larger (Henkle, 1990).

Rock slides and debris flow tracks and deposits are abundant on the north and northwest slopes of Sugarloaf Mountain. Henkle (1990) attributes this to the relatively high elevation (3600-5000 feet) and north aspect releasing large volumes of water from warm rains on a snowpack.

TABLE 4.5
HYDROLOGIC PARAMETERS OF INDIGO SUB-WATERSHEDS

	Lower Indigo	North Fork	West Indigo	East Indigo	Lazy	Snail	Brandy	Slim	Breezy	Chief	Upper WF	Upper EF
Acres Drainage Area	10793	8494	6184	7978	1653	3721	902	760	1547	1763	3535	2029
Miles Perennial Fish Bearing Stream	11.15	5.98	5.55	10.88	1.51	4.32	0.46	0	1.39	2	5.94	1.15
Miles of Non-Fish Bearing Stream	38.49	32.9	26.81	36.93	7.04	15.18	4.5	3.95	6.18	8.26	11.82	10.66
Acres Perennial Riparian Reserve	2408	1770	1486	2274	400	922	218	161	349	475	914	512
Average Stream Gradients in percent	1 to 4		1 to 8		8		11 to 23	10		3		
Range of 7 Day High Stream Temp F at Mouth	69 to 73	66.7 to 69.3	59.7	62 to 63.5	59.3	59 to 60			61 to 63.9	58.6 to 61	59 to 60	59.3 to 62.7
Range of Summer Low Flow in CFS	13 to 37	2.2 to 3.04	8.8 to 12.8	6.1 to 10.4	.41 to 1.05	.43 to 1.03			.62 to 2.96	.5	3.67	.32

TABLE 4.6
SERAL STAGE OF RIPARIAN RESERVE
(Percent by Acreage)

	Lower Indigo	North Fork	West Indigo	East Indigo	Lazy	Snail	Brandy	Slim	Breezy	Chief	Upper WF	Upper EF
Early Seral by Harvest	7	12	2	10	16	4	0	0	8	15	1	26
Early Seral Other	42	25	42	49	18	43	54	75	30	32	55	21
Mid Seral by Harvest	0	0	0	0	0	0	0	0	0	0	0	0
Mid Seral Other	21	24	22	15	17	18	19	13	17	18	15	16
Late Seral Harvest	0	0	0	0	0	0	0	0	0	0	0	0
Late Seral Other	30	39	34	26	49	35	27	12	45	35	29	37

4.6 EXISTING STREAM SURVEY DATA

Stream survey data exists for the following stream segments:

- Indigo Creek from confluence with Illinois River to confluence with West and East Fork of Indigo Creek, approximately 8.1 miles. Surveyed in 1990 and 1995.
- West Fork Indigo Creek from confluence with East Fork upstream for approximately

3.2 miles. Surveyed in 1991 and 1994.

- East Fork Indigo Creek from confluence with West Fork upstream for approximately 5.9 miles. Surveyed in 1992 and 1994.
- Snail Creek from confluence with West Fork upstream for approximately 3.6 miles. Surveyed in 1991.
- Breezy Creek from confluence with East Fork upstream for approximately 1.3 miles. Surveyed in 1992.
- Other tributaries for approximately 0.3 miles. Slim and Brandy Creeks were surveyed in 1991.

REFERENCES AND PROCESS RECORDS

General:

Natural Resources Conservation Service (NRCS), in press, Soil Survey of Curry County, Oregon

Ramp, L., Schlicker, H.G., and Gary, J.J., 1977, Geology, mineral resources and rock material of Curry County, Oregon: Oregon Dept. Geol. and Mineral Industries Bull. 93, 79 pp.

Ramp, L., and Peterson, N.V., 1979, Geology and mineral resources of Josephine County, Oregon: Oregon Dept. Geol. and Mineral Industries Bull. 100, 45 pp.

Smith, J.G., Page, N.J., Johnson, M.G., Moring, B.C., and Gray F., 1982, Preliminary geologic map of the Medford 1 x 2 degree quadrangle, Oregon and California.

USDA, Siskiyou National Forest, 1979, Soil Resource Inventory.

USDA, Siskiyou National Forest, 1990, Raspberry Timber Sale Report: Slope Stability, by Ricks.

USDA, Siskiyou National Forest, 1994, Indigo Creek and Tributaries,Wild And Scenic Eligibility Study: Geological/Hydrological section by Cornell and Carroll.

Silver Fire Recovery Project

Landslide inventory - data on disk

Watershed Sensitivity map - not in GIS

West Indigo Planning Area

Henkle and Associates, Consulting Geologists, 1990, Reconnaissance Slope Stability, Soils and Geology Mapping: Lazy and Snail Planning Areas, Siskiyou National Forest, Josephine and Curry County, Oregon (Contract Report). Landslide data on disk.

Landslide map by Joe Cornell - associated data missing?

Watershed Sensitivity map

INDIGO CREEK WATERSHED ANALYSIS

APPENDIX A
WILDLIFE TABLES

TABLE A1
FIRST APPROXIMATION OF THE DESIRED CONDITION FOR WILDLIFE HABITAT COMPONENTS

(Using Information from Indigo and Other Watershed Analyses)

Habitat Components	Reference /Desired Condition
Big Trees (>32"d.b.h.) Indigo Creek, East Fork Illinois River, Althouse Creek, and Sucker Creek (non-serpentine).	40% of area dominated by big trees
Big Trees (>32"d.b.h.) in Riparian Reserves (class 1-3 streams) Indigo Creek, East Fork Illinois River, Althouse Creek, and Sucker Creek (non-serpentine).	45% of area dominated by big trees
Mature (21-32" dbh) and Old Growth (>32"dbh) conifer and hardwood	45-75% of landscape (REAP) with 75% in LSRs (pg. 36, SW Oregon LSR Assessment); at the stand scale, 8-16 mature trees, 8-16 old growth trees per acre., and numerous hardwoods at stand scale (Bingham and Sawyer, 1991)
Interior Mature and Old Growth (non-serpentine) conifer and hardwood (19%- Althouse, 25% Caves & Grayback, 35% Indigo	25-35%
Small conifer and hardwood (9-21"dbh)	20%
Seed/Sap/Pole (<9"dbh)	Maintain 20% of area in forage for deer and elk (Siskiyou LRMP) and 180 other associated species (Brown 1985). Much of this 20% would be from seed-sap-pole; however, meadows and under-burned mature and old growth would also contribute if overstory canopy closure is reduced and/or canopy gaps are present. Have 150-400 trees per acre to allow for maximum tree growth.
Grass/Forb openings and forest understory	2% and (data gap concerning understory coverage)
Cliffs, Rock outcrops, Caves, and Talus	Maintain as undisturbed areas
Dead Wood: Large Woody Material and Snags	Meet Standards and Guidelines from amended Siskiyou Forest Plan as described in Guidelines for Harvest Prescriptions; Large Woody Material, Green Tree Retention, [and] Wildlife Reserve (Snag) Tree Retention (14 Nov. 1996).
Pine/Oak Savanna	Restore as much s possible.

Indigo Creek watershed contains 49,064 ***acres***; the Galice portion is 30,540 acres or 62%, the Gold Beach portion is 18,261 acres or 37%, and BLM is 263 acres or 1%. 63% of Indigo is in Curry County while 37% is in Josephine County. 11% of the watershed has been harvested; the majority of the area harvested was old growth and mature forest.

TABLE A2
HABITAT COMPONENTS IN INDIGO CREEK WATERSHED

Habitat Components	Current Condition; Indigo	Historic/Reference Condition: Indigo	
	PMR Pixel Data	Modeled PMR Pixel Data To Pre-Harvest Condition	1950 Timber Inventory
Non-Forest	steady state	Steady state	2563 ac. or 5%
Grass/Forb	less than the past	Data Gap	3012 ac. or 6%
Shrub Dominated	2370 ac. or 5%	1585 ac. or 3%	
Seed/sap/pole (<9"dbh)	11268 ac. or 23%	7716 ac. or 16%	4110 ac. or 8% (3%burned area)
Young Forest (9-21" dbh)	12844 ac. or 26%	12321 ac. or 25%	7382 ac. or 15% (5%dominated by hardwoods)
Mature Forest (21-32" dbh)	8709 ac. or 18%	8348 ac. or 17%	31610 ac. or 64%
Old Growth (> 32" dbh)	13497 or 28%	18746 ac. or 38%	
Interior Older Forest (Mature and Old Growth patches larger than 20 ac.)	10893 ac. or 22% a 6725 ac. or 38% reduction from historic, in 44 patches; with 3 patches over 500 acres (3399, 2812, & 614 ac.) - 62% - and 5 patches over 250 acres (331, 430, 340, 410, and 469ac.)	17618 ac. or 35% in 14 patches with the vast majority - over 80% - in one patch that connected all major sub-basins	
Cliffs, Rock outcrops, Caves, and Talus	Sometimes impacted by rock pit and road development. Also impacted by timber harvest effects on microclimate, esp. on talus. Fire suppression has increased stand densities, therefore may have increased humidity on talus microclimate.	Essentially undisturbed except for some fire impacts.	
Dead Wood: Large Woody Material and Snags	Reduced amounts of high concentrations of class 1 & 2 pieces of dead wood due to fire suppression, fire salvage, and timber harvest. The landscape may have more background levels of dead wood over the watershed due to fire suppression preventing consumption by frequent fires, especially older (class 3+) down wood.	Historic conditions are unknown. Reference conditions were established using eco-plot data and used to establish Direction for the Siskiyou National Forest for different plant series' "Guidelines for Harvest Prescriptions; Large Woody Material, Green Tree Retention, [and] Wildlife Reserve (Snag) Tree Retention (14 Nov. 1996).	
Pine/Oak Savanna	There is a very small amount of this habitat in the Indigo ecosystem. An area on Burnt Ridge, the North Fork, is heavily encroached. Most of the areas with pine/oak savannas are nearly gone, due to heavy encroachment by Douglas fir and other vegetation. Many pines, especially the big ones, are dead or dying. Some large black oaks and white oaks remain among encroachment but will likely be dead within ten or twenty years.	Historically, this habitat was limited in the watershed. this habitat is maintained by frequent natural and many human caused fires on productive soils.	

TABLE A3
HABITAT COMPONENTS – FOREST SIZE/STRUCTURE - IN RIPARIAN RESERVES

Habitat Components	Riparian Reserves: Current Condition (PMR); Indigo			Riparian Reserves: Historic/Reference Condition (PMR): Indigo		
	Class 1&2; 4156 ac.	Class 3; 7736 ac.	Classes 1,2,&3; 11889 ac. or 24%	Class 1&2; 4156 ac.	Class 3; 7736 ac.	Classes 1,2,&3; 11889 ac. or 24%
Grass/Forb	191ac. 4%	202ac 2%	8 ac. .7%	173ac. 4%	143ac. 1%	318ac. 3%
Shrub Dominated			324 ac. 3%			
Seed/sap/pole	812ac. 19%	1610ac. 20%	2255 ac. 19%	634ac. 15%	1200ac. 15%	1834ac. 15%
Young Forest (9-21" dbh)	944ac. 22%	1963ac 25%	2912 ac. 25%	985ac 23%	1867ac. 24%	2852ac. 23%
Mature Forest (21-32" dbh)	805ac. 19%	1444ac. 18%	2427 ac. 20%	773ac. 18%	1369ac. 17%	2162 ac. 18%
Old Growth (> 32" dbh)	1363ac. 32%	2514ac. 32%	3882 ac. 33%	1550ac. 37%	3122ac. 40%	4672 ac. 39%

TABLE A4
TRENDS FOR HABITAT COMPONENTS

(Assumes continued successful fire suppression, which becomes less likely as more time passes and fuels increase)

Habitat Components	Trend: Past 100 Years	Trend: Future 100 Years For Various Siskiyou NF Land Allocations Under Current Land Management Plan (Amended Siskiyou Forest Plan).		
		Matrix -Includes Intermittent Streams- **(6%)**	**Riparian Reserve (24%-** Not Including Intermittent Streams) **By Matrix (data gap%)**	**LSR (84%** Includes Uplands, Intermittent Streams, And Most, But Not All, Riparian Reserve Areas)
Grass/Forb	Large areas lost to tree encroachment in meadows and mature and old growth areas. Until the past five to ten years, fall burning of clearcuts created good conditions for grasses and forbs. Cooler spring burns of the recent past do not create favorable conditions for this habitat element.	Same as recent past; cool spring burns reduces chances of grass/forb establishment. Timber objectives usually try to avoid grass/forb establishment to avoid tree-grass/for competition.	Same as past 100 years except some meadows will be restored.	Same as past 100 years except some meadows will be restored.
Shrub Dominated	Shrub dominated areas reduced by tree encroachment.	Shrub domination will be avoided on land suitable for timber mgmt.	Reduced from trend as trees grow into larger size classes. Trend will continue	Reduced from trend as trees grow into larger size classes. Trend will continue
Pole/Sapling	Increased by timber harvest and fire suppression.	Will be maintained.	Reduced from trend as trees grow into larger size classes.	
Young Forest (9-21" dbh)	Increased by timber harvest	Will be maintained.	Reduced from trend as trees grow into larger size classes.	
Mature Forest (21-32" dbh)	Increased as young forest grew into larger trees.	Will be reduced	Increase from trend as trees grow into larger size classes.	
Old Growth (> 32" dbh)	Reduction of about 10% in watershed compared to pre-harvest condition	Will be reduced	Amounts will increase but distribution may not resemble historic distributions.	
Interior Mature and Old-Growth (400 ft. edge effect)	Harvest strategies have generally maximized fragmentation by dispersing harvest over the landscape and harvesting relatively small areas (i.e. less than 60 acres) compared to pre-harvest conditions.	Will be eliminated unless harvest strategies change to maintain and develop interior habitat. It would be possible, simply by aggregating harvest, for over 40% of Matrix and Riparian Reserve areas to have interior older forest habitat over time.	Changed harvest strategies in Matrix could use Riparian Reserves as foundation for interior habitat and better connectivity (than Riparian Reserves alone).	Will increase over the next 50-100 years, assuming fire suppression remains successful, which is uncertain. With density reduction (using fire and/or mechanical methods) an increase could be expected.
Cliffs, Rock outcrops, Caves, and Talus	Rock pit and road development peaked in the 1970's and 1980's and has declined in the 90's, so impacts to cliffs and talus have also declined. Also impacted by timber harvest effects on microclimate, esp. on talus. Fire suppression has increased stand densities, therefore increased humidity on talus microclimate.	Where occupied by Del Norte salamanders, adequate microclimate humidifies will be maintained on talus. Some rock pits will remain open.	Microclimate humidity will recover in areas disturbed by roading or harvest. Some rock pits will remain open. Humidity will increase, as forest stands grow and canopy closure increases, until fire or other density reducing disturbances occur.	

Habitat Components	Trend: Past 100 Years	Trend: Future 100 Years For Various Siskiyou NF Land Allocations Under Current Land Management Plan (Amended Siskiyou Forest Plan).		
		Matrix -Includes Intermittent Streams- (6%)	Riparian Reserve (24%- Not Including Intermittent Streams) By Matrix (data gap%)	LSR (84% Includes Uplands, Intermittent Streams, And Most, But Not All, Riparian Reserve Areas)
Dead Wood: Large Woody Material and Snags	Unmanaged stands: increase in how long dead wood lasts, due to fire suppression. Decrease of area with high densities of dead wood due to fire suppression, fire salvage, and timber harvest. Managed Stands: Most timber harvest areas are below desired levels, especially for snags. Early timber cutting left more down wood than cutting over most of the past 30 years has. Recent harvest left more.	Increase in the amounts left in harvest units. A better understanding of natural levels will lead to better mgmt of dead wood.	Increased amounts, as high stand densities cause mortality of trees (including large sizes). An increase in the amount of intense fires (caused by fire in high density stands) could create vast areas of large woody material and snags.	
Pine/Oak Savanna (provide food for more animal spp than any other plants (Zimmer and Martin(195?)	Most of the areas with pine/oak savannas have been heavily encroached by Douglas fir and other trees. Most pines, especially the big ones, are dead or dying. Some large black oaks and white oaks remain among encroachment but most will likely be dead within ten or twenty years.	Restoration may occur, but would cause a negligible reduction of timber outputs in future years.	Restoration may occur if funding is available.	

TABLE A5
SUMMARY OF RECOMMENDATIONS FOR MAINTENANCE AND RESTORATION OF HABITAT ELEMENTS

Habitat Components	Recommendations		
	Matrix (6%)	Riparian Reserve (24%-Does Not Include Intermittent Streams) By Matrix	LSR (84%)
Grass/Forb	Underburn young, mature, and old growth forests. Burn regeneration harvest units hot enough to provide a seed bed for grasses and forbs. Restore and maintain meadows and pine/oak savannas, both inside and outside of riparian reserves Forested riparian zones in meadows may be less than 300 feet. Use native species when seeding disturbed areas. Priorities for treatment are areas where elk occur. Numerous meadow restoration opportunities exist, e.g., Corrals Prairie, Upper Slim Creek, upper Brandy Creek, Salt Block meadow, Indigo Prairie, and Fish Hook Wildlife Area.		
Shrub Dominated	Use prescribed fire to maintain brush fields, and use fire and/or mechanical treatment to maintain shrubs in portions of managed stands.		
Seed/Sap/Pole	Use stand management (regeneration or widely spaced thinning) and prescribed natural fire to maintain seed/sap/pole habitat. Also extend the time which seed-sap-pole habitat provides grass, forb, and shrub habitat for 180 associated species (Brown et al. 1985) with density treatments; priority areas are elk winter range (i.e., south aspects with < 40% slope). Past harvest units that are now in LSR and riparian reserves are heavily overstocked with conifer and hardwood trees and are encountering intense competition from brushy species. Use silvicultural treatments (thinning) inside LSR managed stands, including managed riparian reserves to create and maintain LSR conditions.		
Young Forest (9-21" dbh)	Reduce potential fire intensity by reducing ground and understory fuels, increasing the distance to overstory crown, and reducing the density of overstory crown to lower crown fire potential (Agee 1997). Maintain hardwoods. Priority areas are driest portions of Riparian Reserves, next to roads (fire and economics), and adjacent to interior mature and old growth stands (especially those occupied by nesting spotted owls).		
Mature Forest (21-32" dbh)	Develop future large trees (> 32" dbh) for Green Tree Retention.	At the watershed scale, manage for 45-75% mature and old growth, with around 40% of this in old growth. Because 6% of the watershed is in Matrix, manage for 55-85% mature and old growth in LSRs and 45-75% in Riparian Reserves, with about 45% in old growth for both of these land allocations. At the stand scale, manage for 8-16 mature conifers per acre, 8-16 old-growth sized trees per acre, and the appropriate amount of hardwoods (Bingham and Sawyer, 1991). A significant amount of the large trees should have deformities such as cavities, witch's brooms (from mistletoe), and large limbs. Priority restoration areas are 1- mature, 2- young, and 3- seed-sap-pole forest adjacent to interior mature and old-growth forest and within riparian reserves to increase connectivity between interior patches. Priority areas are within WAAs: 08N05W, 08W04F - 10W, 08E04W, and 08E06W - 10W. Treatments could include thinning, underburning, and/or snag and down wood creation. See the map following Table F for locations of commercial thinning (8,000 acres) and underburning (16,000 acres) opportunities. These areas present an excellent opportunity for hastening the development of mature stands. Furthermore, most of the commercial thinning areas are on aspects prone to intense fires (south and east), and these areas are densely stocked with continuous canopies on steep slopes. These conditions combine to increase the probability of losing many of these acres to stand replacement fire. Commercially thinning and then underburning should, in the short-term help to maintain these areas; and in the long term hasten restoration of mature and old-growth habitat (Agee, 1997). Priority areas to prevent stand replacement fires are within interior mature and old growth habitat patches, esp., the largest ones, i.e., in North Fork Indigo and Snail Creeks. Treatments could include underburning and suppression of wildfire when burning conditions are too intense.	
Old Growth (>32" dbh)	Meet green tree retention Standards and Guidelines		

Habitat Components	Recommendations		
	Matrix (6%)	**Riparian Reserve (24%-Does Not Include Intermittent Streams) By Matrix**	**LSR (84%)**
Interior Mature and Old Growth (400ft. edge effect)	Maintain as long as possible or until restoration is complete in the entire watershed. Aggregate harvest to minimize fragmentation. Restore connections to other interior patches and areas adjacent to existing patches.	As Above	
Cliffs, Rock outcrops, Caves, and Talus	Maintain the majority as undisturbed areas; survey for species like peregrine falcon, bats, and Del Norte salamander prior to disturbance.		
Dead Wood: Large Woody Material and Snags	Manage for low amounts next to ridgeline roads where the chances for stopping fires are best		
	Manage between low and average range	Manage around high end of range for most areas, and beyond for some areas.	Manage around the mean for most areas, and beyond for some areas.
Pine/Oak Savanna (provide food for more animal spp. than any other plants (Zimmer and Martin, 195?)	Reduce encroachment. Maintain savannas, after removing encroachment, by burning as frequently as needed (about every 5 years). Priority locations are anywhere this habitat is found, e.g., on Burnt Ridge in North Fork Indigo Creek.		

TABLE A6
HABITAT ELEMENTS: AMOUNT NEEDED TO RESTORE TO DESIRED CONDITION

Habitat Components	Current Condition	Desired Condition	Amount Needed to Restore to Desired Condition
Grass/Forb	Much less than the past	Meadows restored and grass/forb abundance increased in forested habitats: 2% - 5%	Data Gap
Shrub Dominated	5%	3-8%	Data Gap
Pole/Sapling	23%	20%	-29%
Young Forest	26%		
Mature Forest - 21-32" dbh - (8-16 trees per acre)	18%	30%	12%
Old Growth - >32" dbh – (8-16 trees per acre)	28%	45%	12%
Interior Mature and Old-Growth	22%	35%	17%
Cliffs, Rock outcrops, Caves, and Talus	Developed rock pits and reduction of micro-climate by timber harvest have degraded habitat quality	Avoid disturbance of peregrine site and minimize disturbance of other sites.	
Dead Wood: Large Woody Material and Snags	Below desired condition in many managed stands	See Siskiyou Guidelines	Meet Siskiyou Guidelines
Pine/Oak Savanna (provide food for more animal spp. than any other plants (Zimmer and Martin, 195?)	Heavily encroached by undesirable trees and brush	Healthy pines and deciduous oaks with grass/forb understory	All places where this habitat occurs

TABLE A7
SPECIES OF CONCERN AND THEIR HABITAT ASSOCIATIONS

COMMON NAME	SPECIES OF CONCERN: why?	PRESENT: yes, no or unknown	DISTRIBUTION: % of suitable habitat surveyed in watershed	ABUNDANCE: % of watershed population surveyed
Peregrine falcon	ESA-endangered	yes	< 1%	0
Bald eagle	ESA-threatened	unlikely resident	<1%	0
Marbled murrelet	ESA-threatened	no	<10%	0
Northern spotted owl	ESA-threatened	yes	>50%	>80%
Olympic salamander	NWP-J2; additional analysis needed	unknown	< 1%	< 1%
Clouded salamander	NWP-J2; additional analysis needed	unknown	< 1%	< 1%
Tailed frog	NWP-J2; additional analysis needed	unknown	< 1%	< 1%
Common merganser	NWP-J2; additional analysis needed	unknown	< 1%	< 1%
Wolverine	R5&6-sensitive	unknown	< 1%	< 1%
Osprey	R6-mgmt. Indicator	potential at Illinois River	<1%	< 1%
Lewis' woodpecker	R6-mgmt. Indicator	likely	< 1%	< 1%
Acorn woodpecker	R6-mgmt. Indicator	likely	< 1%	< 1%
Red-breasted sapsucker	R6-mgmt. Indicator	likely	< 1%	< 1%
Williamson's sapsucker	R6-mgmt. Indicator	likely	< 1%	< 1%
Downy woodpecker	R6-mgmt. Indicator	likely	< 1%	< 1%
Hairy woodpecker	R6-mgmt. Indicator	likely	< 1%	< 1%
White-headed woodpecker	R6-mgmt. Indicator	unlikely	< 1%	< 1%
Northern flicker	R6-mgmt. Indicator	likely	< 1%	< 1%
Pileated woodpecker	R6-mgmt. Indicator	likely	< 1%	< 1%
Roosevelt elk	R6-mgmt. Indicator	resident	>60%	< 1%
Columbian black-tailed deer	R6-mgmt. Indicator	yes	>60%	< 1%
Black- backed 3-toed woodpecker	R6-mgmt. Indicator; NWP-J2; additional analysis	unknown	<1 %	< 1 %
Marten	R6-mgmt. Indicator; R5-sensitive	unknown	<1 %	< 1 %
Red-legged frog	R6-sensitive	unknown	<1 %	< 1 %
Western pond turtle	R6-sensitive	unknown	<1 %	< 1 %
Common kingsnake	R6-sensitive	likely	<1 %	< 1 %
California mountain kingsnake	R6-sensitive	likely	<1 %	< 1 %
Townsend's big-eared bat	R6-sensitive	unknown	<1 %	< 1 %

COMMON NAME	SPECIES OF CONCERN: why?	PRESENT: yes, no or unknown	DISTRIBUTION: % of suitable habitat surveyed in watershed	ABUNDANCE: % of watershed population surveyed
White-footed vole	R6-sensitive	unknown	<1 %	< 1 %
Red tree vole	ROD-survey&mg.	likely	<1 %	< 1 %
Pallid bat	ROD-survey&mg.	unknown	<1 %	< 1 %
Silver-haired bat	ROD-survey&mg.	unknown	<1 %	< 1 %
Long-eared myotis	ROD-survey&mg.	unknown	<1 %	< 1 %
Fringed myotis	ROD-survey&mg	unknown	<1 %	< 1 %
Long-legged myotis	ROD-survey&mg	unknown	<1 %	< 1 %
Great Grey owl	ROD-survey&mg.; R5-sensitive	unknown	<1 %	< 1 %
Del Norte salamander	ROD-survey&mg.; R6-sensitive	yes	<1 %	< 1 %
Siskiyou Mountains salamander	ROD-survey&mg.; R6-sensitive	unknown	<1 %	< 1 %

Key to Table A7: ESA = Endangered Species Act; NWP J2 = Northwest Forest Plan Appendix J2; ROD = Record of Decision for NWP; R6 = Region 6 of USDA Forest Service; R5 = Region 5 of USDA Forest Service; mgmt. Indicator = species used as indicators of effects from management practices.

TABLE A8
WILDLIFE SPECIES OF CONCERN; HABITAT ASSOCIATIONS

Wildlife Habitat Associations	GRASS/FORB	SHRUB DOMINATED	POLE SAPLING FOREST	YOUNG FOREST	MATURE FOREST	OLD GROWTH FOREST	CAVES & BURROWS	CLIFFS & RIMS	LARGE DOWN WOOD	SNAGS	TALUS	RIPARIAN/AQUATIC
COMMON NAME	**1= Primary Habitat 2= Secondary Habitat**											
Peregrine falcon	2	2			2	2		1		2	2	1
Bald eagle	1				2	2				1		1
Marbled murrelet					2	1						2
Northern spotted owl					2	1				2		
Olympic salamander			2	1	1	1					1	1
Clouded salamander	1	1	1	1	2	2			1	2	2	
Tailed frog	2	2	1	1	1	1			1		2	1
Common merganser					1	1			2	1		1
Wolverine							1		1		1	1
Osprey					2	2				1		1
Lewis' woodpecker	2	1	1		2	2			1	1		
Acorn woodpecker			2		2	2			2	1		
Red-breasted sapsucker			2	2	2	2				1		1
Williamson's sapsucker			2	2	2	2				1		
Downy woodpecker			2	2	2	2				1		1
Hairy woodpecker			2	2	2	1			1	1		2
White-headed woodpecker				2	2	1			2	1		
Northern flicker	1	2	2		1	1			1	1		2
Pileated woodpecker				2	2	1			1	1		2
Roosevelt elk	1	1	1	1	1	1						1
Columbian black-tailed deer	1	1	1	2	2	2			2			2
Black- backed 3-toed woodpecker			2	2	2	2				2	1	2
Marten			2	2	1	1	2	2	1	1	2	2

Wildlife Habitat Associations	GRASS/FORB	SHRUB DOMINATED	POLE SAPLING FOREST	YOUNG FOREST	MATURE FOREST	OLD GROWTH FOREST	CAVES & BURROWS	CLIFFS & RIMS	LARGE DOWN WOOD	SNAGS	TALUS	RIPARIAN/AQUATIC
COMMON NAME	**1= Primary Habitat 2= Secondary Habitat**											
Red-legged frog	2			2	2	2						1
Western pond turtle	1	1							1			1
Common kingsnake	1	1	2	2					2		2	
California mountain kingsnake		1	1	1	2	2			2			1
Townsend's big-eared bat		2	1	2			1					2
White-footed vole		2	2	2	1	1			1			1
Red tree vole				2	2	2						2
Pallid bat	1		1	2	2	2	1	1		2		1
Silver-haired bat	2		1	2	2	1	2	2		1		2
Long-eared myotis			2	2	1	1	2		1			1
Fringed myotis	1	1			2	2	1	1		2		1
Long-legged myotis	2	1	1	2	1	1	1	1		1		1
Great Grey owl												
Del Norte salamander				1	1	1			2		1	
Siskiyou Mountains salamander			2	1	1	1			2		1	2
TOTAL NUMBER OF PRIMARY USERS	9	9	10	7	11	17	5	4	11	15	5	18
TOTAL NUMBER OF SECONDARY USERS	6	5	13	18	22	16	3	2	8	6	5	9

TABLE A9
HABITAT COMPONENTS OF SPECIES ASSOCIATED WITH LATE SUCCESSIONAL AND OLD-GROWTH FOREST

(From The Northwest Forest Plan).

Wildlife Habitat Associations With Late Successional And Old Growth Habitats (From Northwest Forest Plan)

Species/ Guilds	LS/OG (large saw/ old growth)	Riparian	Snags	Down Woody Material	Large Green Trees	Canopy Closure	Unique Habitats
Northern spotted owl (FSEIS 3&4, pg. 234+)	large patches	yes	yes	yes	yes	yes	
Marbled Murrelet (FSEIS 3&4, pg. 246+)	trees>32"d.b.h. w/nesting platforms				trees>32"d.b .h. w/nesting platforms		
Bald Eagle (FSEIS pg 206+)	nest				nest trees		large water, i.e., rivers and lakes
Peregrine Falcon (FSEIS, pg. 254+)							cliffs; often forages in forest
Invertebrates: Arthropods (FSEIS, pg. 2-75)	extensive and inter-connected	yes	yes	yes	yes; diversity of old growth	yes; canopy structure	
Invertebrates: Mollusks (FSEIS, pg. 2-76)	LS/OG influences quality of moist habitats	moist forest, i.e.; springs, bogs, marshes					talus: basalt and limestone
Amphibians (FSEIS, pg. 2-76)	extensive and inter-connected. LS/OG influences quality of cool moist habitats	low sediment, cool water, and head-water streams		yes			
Birds (FSEIS, pg. 2-76&77)	large reserves	yes	yes	yes	green trees, large and small		
Bats (FSEIS, pg. 2-77)	yes	yes	yes	yes			
Mammals – other than bats- (FSEIS, pg. 2-77)	yes: some spp. Like fisher may need large unfragmented expanses of LS/OG	yes	yes	yes	yes	some, e.g.; fisher, marten, and tree voles	

TABLE A10
HABITAT COMPONENTS IN SUB-BASINS OF INDIGO CREEK WATERSHED

Habitat Components	Current Condition;	Historic/ Reference Condition (1950 timber invent.)	Current Condition;	Historic/ Reference Condition (1950 timber invent.)	Current Condition;	Historic/ Reference Condition (1950 timber invent.)
	Brandy Creek; 903 ac.		Breezy Creek; 1545 ac.		Chief Creek; 1761 ac.	
Non-Forest		435 ac. 48%		0		0
Grass/Forb	less than the past	0		0		81 ac. 5%
Shrub Dominated	2 ac	65 ac 7%	43 ac. .03%		44 ac. .03%	0
Seed/sap/pole	194 ac. 22%		376 ac. 24%	615 ac. 40%	391 ac. 22%	216 ac. 12%
Young Forest (9-21" dbh)	397 ac. 44%	81 ac. 9%	314 ac. 20%	80 ac. 5%	522 ac. 30%	167 ac. 10%
Mature Forest (21-32" dbh)	150 ac. 17%	321 ac. 36%	219 ac. 14%	841 ac. 54%	303 ac. 17%	1298 ac. 74%
Old Growth (> 32" dbh)	157 ac. 17%		575 ac. 37%		486 ac. 28%	
Interior Older Forest (Mature and Old Growth)	206 ac. 23%	PMR data: 204 ac. 23%	270 ac. 17%	PMR data: 524 ac. 34%	468 ac. 27%	PMR data: 876 ac 50%

Habitat Components	Current Condition;	Historic/ Reference Condition (1950 timber invent.)	Current Condition;	Historic/ Reference Condition (1950 timber invent.)	Current Condition;	Historic/ Reference Condition (1950 timber invent.)
	East Fork Indigo; 7977 Ac.		Indigo Main-Stem; 10786 Ac.		Lazy Creek; 1651 Ac.	
Non-Forest		839 ac. 10%		710 ac. 6%		0
Grass/Forb	less than the past	0		711 ac. 6%		0
Shrub Dominated	698 ac. 9%		730 ac. .07%		23 ac. .01%	
Seed/sap/pole	2706 ac. 34%	1147 ac. 13%	2351 ac or 22%	108 ac. <1%	336 ac. 20%	0
Young Forest (9-21" dbh)	1757 ac. 22%	1367 ac. 17% (8% hardwood)	2482 ac. 23%	1825 ac. 16% (8%hardwood)	366 ac. 22%	416 ac. 25%
Mature Forest (21-32" dbh)	1035 ac. 13%	4577 ac. 57%	2255 ac. 21%	7438 ac. 68%	261 ac. 16%	1237 ac. 74%
Old Growth (> 32" dbh)	1669 ac. 21%		2898 ac. 27%		655 ac. 40%	
Interior Older Forest (Mature and Old Growth)	671 ac. 8%	PMR data· 1551 ac. 19%	207 5ac. 19%	PMR data· 2930 ac. 27%	617 ac. 37%	PMR data: 1113 ac. 67%

Table A10 (Continued)

Habitat Components	Current Condition;	Historic/ Reference Condition (1950 timber invent.)	Current Condition;	Historic/ Reference Condition (1950 timber invent.)	Current Condition;	Historic/ Reference Condition (1950 timber invent.)
	North Fork Indigo; 8491 ac.		Slim Creek; 757 ac.		Snail Creek; 3720 ac.	
Non-Forest		0		228 ac. 29%		75 ac. 2%
Grass/Forb	less than the past	331 ac. 3%		20 ac. 2%		323 ac. 8%
Shrub Dominated	148 ac. < 1%		1 ac < 1%		142 ac. .04%	
Seed/sap/pole	1748 ac. 21%	0	235 ac. 31%	437 ac. 57% (15%burned area)	751 ac. 20%	328 ac. 8%
Young Forest (9-21" dbh)	191 ac. 23%	1000 ac. 11% (1% hardwood)	343 ac 45%	7 ac. <1%	1167 ac. 31%	282 ac. 13% (5%hardwood)
Mature Forest (21-32" dbh)	1842 ac. 22%	7171 ac. 83% (1%large hardwood)	99 ac. 13%	68 ac. 8%	609 ac. 16%	2713 ac. 72%
Old Growth (> 32" dbh)	2728 ac. 32%		77 ac. 10%		1042 ac. 28%	
Interior Older Forest (Mature and Old Growth)	2892 ac. 34%	PMR data: 5243 ac. 62%	50 ac. 6%	PMR data 50 ac. 6%	1435 ac. 39%	PMR data: 1746 ac. 47%

Habitat Components	Current Condition;	Historic/ Reference Condition (1950 timber invent.)	Current Condition;	Historic/ Reference Condition (1950 timber invent.)	Current Condition;	Historic/ Reference Condition (1950 timber invent.)
	Upper East Indigo; 2025 Ac.		Upper West Indigo; 3231 Ac.		West Fork Indigo; 6179 Ac.	
Non-Forest		0		126 ac. 3%		147 ac. 2%
Grass/Forb		110 ac. 5%		128 ac. 3%		1184 ac. 19%
Shrub Dominated	5 ac.		9 ac. < 1%		520 ac. 8%	
Seed/sap/pole	435 ac. 22%	589 ac. 28% (10%burned area)	442 ac. 14%	670 ac. 19% (8%burned area)	1296 ac. 21%	0
Young Forest (9-21" dbh)	572 ac. 28%	119 ac. 5%	1378 ac. 43%	1127 ac. 34%	1573 ac. 26%	1159 ac. 17% (12% hardwood)
Mature Forest (21-32" dbh)	348 ac. 17%	1211 ac. 59%	548 ac. 17%	1184 ac. 36%	1034 ac. 17%	3694 ac. 59%
Old Growth (> 32" dbh)	640 ac. 32%		844 ac. 26%		1719 ac. 28%	
Interior Older Forest (Mature and Old Growth)	439 ac. 22%	PMR data: 1069 ac. 53%	795 ac. 25%	PMR data: 1023 ac. 32%	976 ac. 16%	PMR data: 1291 ac. 21%

TABLE A11
HABITAT COMPONENTS IN RIPARIAN RESERVES OF SUB-BASINS

Habitat Components	Current Condition;			Historic/ Reference Condition:			Current Condition;			Historic/ Reference Condition:		
	Brandy Creek;% Of Stream Class With Habitat Component In Riparian Reserve						Breezy Creek; % Of Stream Class With Habitat Component In Riparian Reserve					
	1&2	3	1, 2,& 3	1&2	3	1, 2,& 3	1&2	3	1, 2,& 3	1&2	3	1, 2,& 3
Acres	**40**	**178**	**218**				**118**	**231**	**349**			
Non-forest									0			
Seed/sap/pole	5	12	11.5	5	12	11	6	15	15.8	7	12	10
Young Forest (9-21" dbh)	40	42	42.2	40	42	42	21	20	20.6	21	20	20
Mature Forest (21-32" dbh)	12	19	18.3	12	20	19	22	13	16.6	22	13	16
Old Growth (> 32" dbh)	37	24	27.1	37	25	27	47	41	43.8	45	53	50

Habitat Components	Current Condition;			Historic/ Reference Condition:			Current Condition;			Historic/ Reference Condition:		
	Chief Creek;% Of Stream Class With Habitat Component In Riparian Reserve						East Fork ;% Of Stream Class With Habitat Component In Riparian Reserve					
	1&2	3	1, 2,& 3	1&2	3	1, 2,& 3	1&2	3	1, 2,& 3	1&2	3	1, 2,& 3
Acres	**167**	**308**	**475**				**881**	**1393**	**2274**			
Non-forest	5	1	3				9	5	6	9	4	6
Seed/sap/pole	22	13	16	4	6	6	26	34	31	15	30	25
Young Forest (9-21" dbh)	17	30	30	14	29	24	16	23	21	22	18	20
Mature Forest (21-32" dbh)	16	19	18	13	19	17	14	15	15	13	14	14
Old Growth (> 32" dbh)	36	33	35	65	43	51	32	22	26	37	31	33

Table A11 (Continued)

Habitat Components	Current Condition;			Historic/ Reference Condition:			Current Condition;			Historic/ Reference Condition:		
	Indigo Mainstem;% Of Stream Class With Habitat Component In Riparian Reserve						Lazy Creek;% Of Stream Class With Habitat Component In Riparian Reserve					
	1&2	3	1, 2,& 3	1&2	3	1, 2,& 3	1&2	3	1, 2,& 3	1&2	3	1, 2,& 3
Acres	**915**	**1493**	**2408**				**126**	**274**	**400**			
Non-forest	8	4	6	8	4	6						
Seed/sap/pole	26	17	21	25	13	18	19	10	13	7	5	6
Young Forest (9-21" dbh)	18	22	21	18	22	20	22	19	23	19	16	17
Mature Forest (21-32" dbh)	21	20	21	20	20	20	16	17	17	15	15	15
Old Growth (> 32" dbh)	23	33	30	26	40	35	40	52	49	56	61	59

Habitat Components	Current Condition;			Historic/ Reference Condition:			Current Condition;			Historic/ Reference Condition:		
	North Fork ;% Of Stream Class With Habitat Component In Riparian Reserve						Slim Creek;% Of Stream Class With Habitat Component In Riparian Reserve					
	1&2	3	1, 2,& 3	1&2	3	1, 2,& 3	1&2	3	1, 2,& 3	1&2	3	1, 2,& 3
Acres	**497**	**1273**	**1770**				**3**	**158**	**161**			
Non-forest			0									
Seed/sap/pole	11	18	17	9	6	7		26	26		26	26
Young Forest (9-21" dbh)	20	19	20	19	19	19	33	46	46	33	46	46
Mature Forest (21-32" dbh)	28	20	23	27	19	22		13	13		13	13
Old Growth (> 32" dbh)	38	38	39	42	52	50		12	12		12	12

Table A11 (Continued)

Habitat Components	Current Condition;			Historic/ Reference Condition:			Current Condition;			Historic/ Reference Condition:		
	Snail Creek;% Of Stream Class With Habitat Component In Riparian Reserve						Upper East Fork; % Of Stream Class With Habitat Component In Riparian Reserve					
	1&2	3	1, 2,& 3	1&2	3	1, 2,& 3	1&2	3	1, 2,& 3	1&2	3	1, 2,& 3
Acres	**361**	**561**	**922**				**100**	**412**	**512**			
Non-forest		2	1									
Seed/sap/pole	6	18	13	6	14	11	15	24	22	4	5	5
Young Forest (9-21" dbh)	32	31	31	32	30	31	31	21	23	27	19	20
Mature Forest (21-32" dbh)	20	16	18	19	16	17	16	16	16	11	13	13
Old Growth (> 32" dbh)	39	31	34	40	37	38	35	36	36	55	59	58

Habitat Components	Current Condition;			Historic/ Reference Condition:			Current Condition;			Historic/ Reference Condition:		
	Upper West Fork; % Of Stream Class With Habitat Component In Riparian Reserve						West Fork; % Of Stream Class With Habitat Component In Riparian Reserve					
	1&2	3	1, 2,& 3	1&2	3	1, 2,& 3	1&2	3	1, 2,& 3	1&2	3	1, 2,& 3
Acres	**490**	**424**	**914**				**451**	**1035**	**1486**			
Non-forest							1	1	1	1	2	1
Seed/sap/pole	14	12	14	14	13	14	19	18	18	19	18	18
Young Forest (9-21" dbh)	38	44	41	38	44	41	21	23	22	20	24	23
Mature Forest (21-32" dbh)	15	15	15	15	15	15	20	22	21	20	21	21
Old Growth (> 32" dbh)	29	26	28	29	27	28	37	33	34	36	33	34

Table A12
Wildlife Modeling Assumptions

Habitat Components	Current Condition; Indigo	Historic/Reference Condition: Indigo	
	PMR Pixel Data: Size Structure Codes	Modeled PMR Pixel Data To Pre-Harvest Condition : Size/Structure Codes	1950 Timber Inventory: Size Codes
Non-Forest			38
Grass/Forb			2, 23!, 29!, U
Shrub Dominated			
Seed/sap/pole (<9"dbh)	10, 11, 27, 30, 33, 35, 36	10, 11, 12, 24, 27, 30, 33, 35, 36	10, 13, 16, 22, 24, 26A, 28_5, 28B, 30, 37
Young Forest (9-21" dbh)	12, 13, 14, 20, 24, 37, 38	13, 14, 15, 16, 21, 22, 28, 29	4, 9, 9A, 9B, 12A, 12B, 15A, 15B, 19A, 19B, 21, 25, 26, 28A, 31
Mature Forest (21-32" dbh)	15, 16, 21, 22, 23, 37, 38	16, 25	6, 8, 11, 14, 17, 17IC, 18, 20, 20_5, 20A, 23, 27, 27_5, 29, 31_5
Old Growth (> 32" dbh)	17, 18, 19, 26,29, 31, 32, 34	17, 18, 19, 26,29, 31, 32, 34	
Interior Older Forest (Mature and Old Growth patches larger than 20 ac.)	Combined Mature and Old Growth and subtracted 400 ft . from the outside edge of stands for "edge effect." The remaining area is "interior habitat."	Combined Mature and Old Growth and subtracted 400 ft . from the outside edge of stands for "edge effect." The remaining area is "interior habitat."	

! = Classification errors. Total acres affected by this error are 410. These codes should be in Mature and Old Growth. These errors are relatively insignificant.

* = General modeling assumptions using PMR pixel data to develop "pre-harvest condition" data -

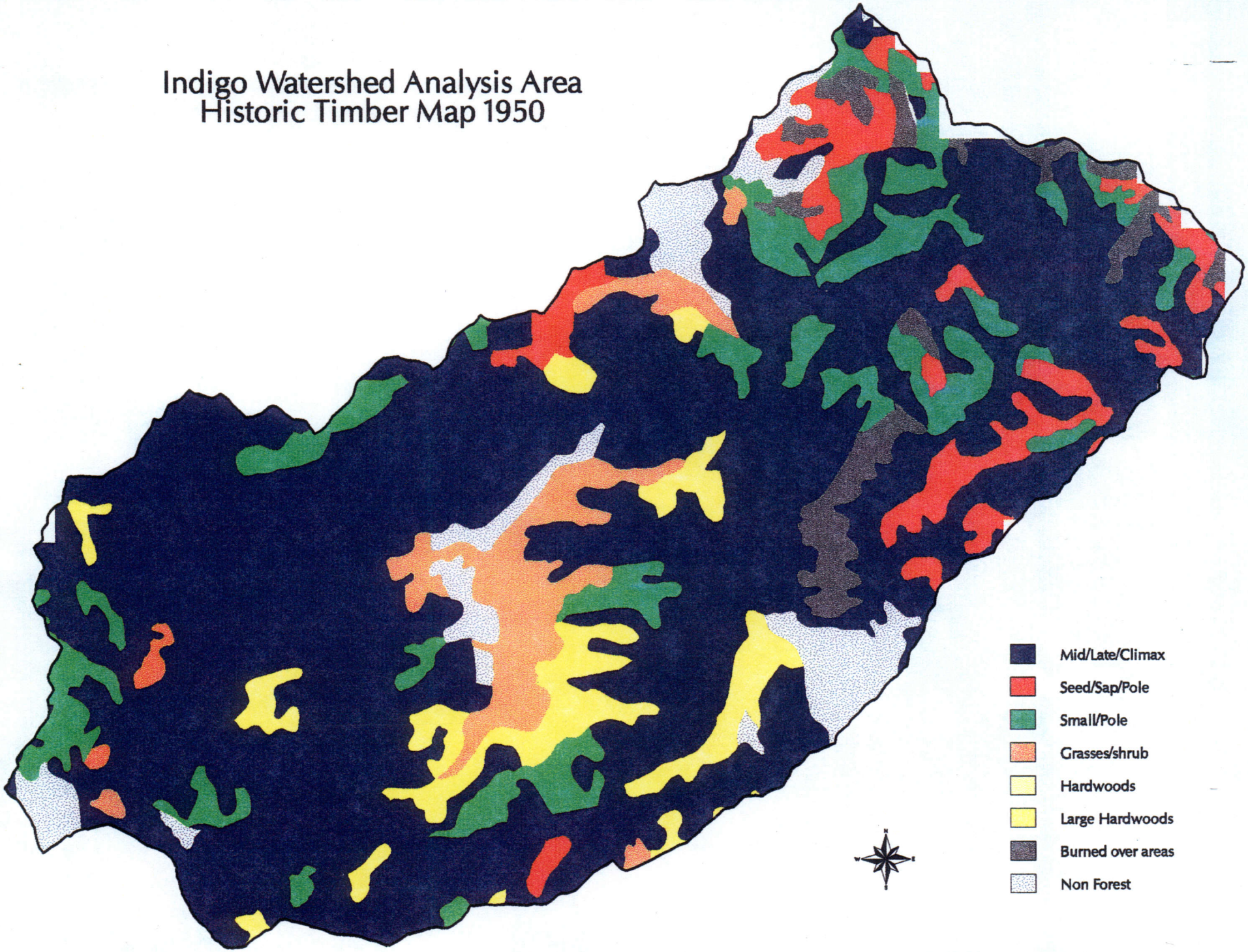
Before timber harvest:
all current regeneration harvest areas were old-growth,
unmanaged forests of old-growth were old-growth,
unmanaged mature forests were young forests,
unmanaged young forests were pole forests, and
unmanaged seed/sap/pole forests remained the same.
Other unmanaged habitats, (i.e., water, rock, grass, shrub) remained the same.

It is difficult to model pre-harvest conditions for young and seed/sap/pole stands; therefore, PMR historic/reference information for these size classes has limited value. Contrasting between the current condition with PMR data and the historic condition with 1950 Timber data should be the most accurate comparison for these size classes.

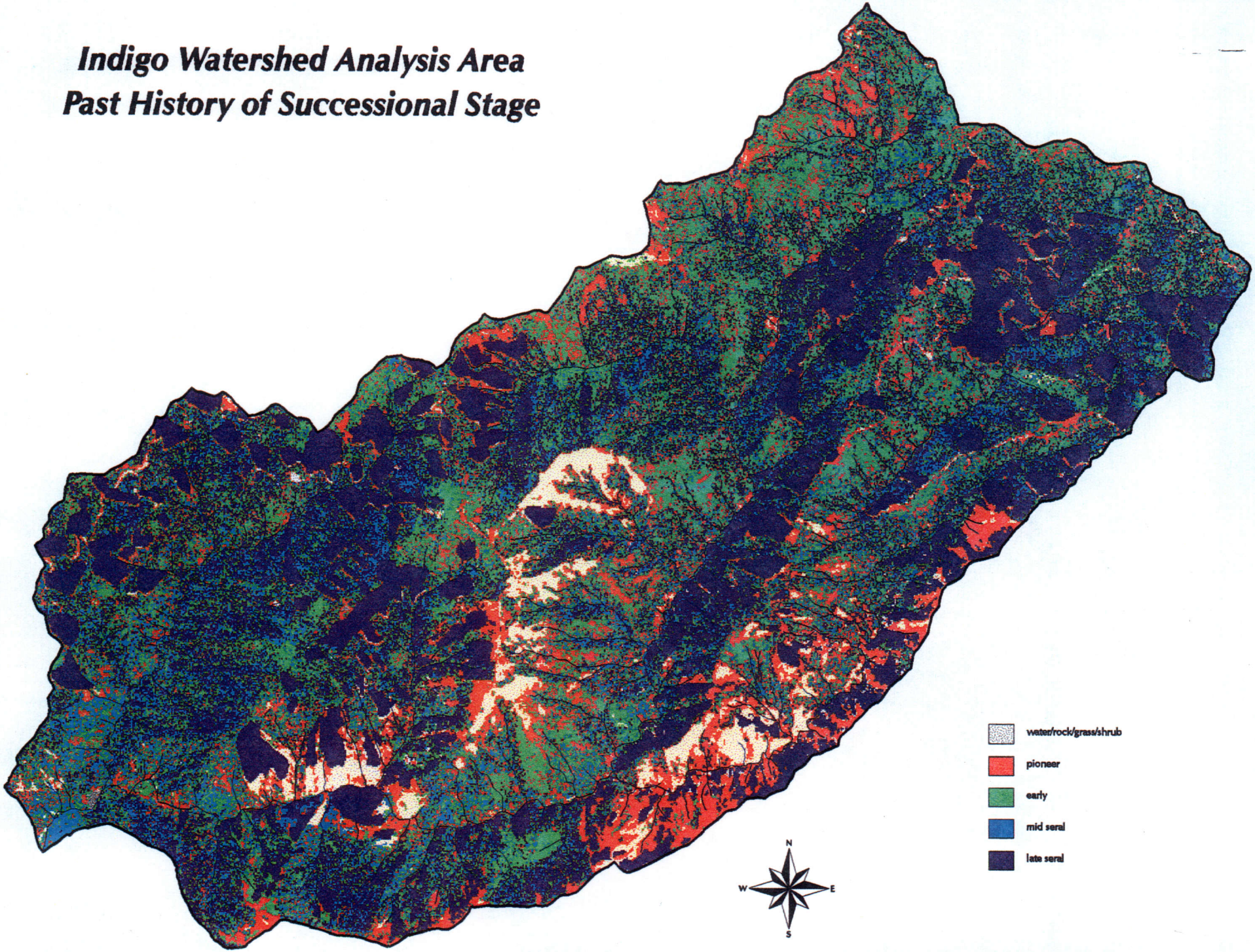
PMR data resolution is much higher (about 1/5 acre) than 1950 Timber data (about 30 acres) so detailed, small scale comparisons is not possible. However, at sub-basin or watershed scales, comparisons are very useful for beginning to understand how wildlife habitat conditions have changed and what the distribution and abundance of various habitats were under more natural conditions.

For more precise information about these assumptions, see the data dictionary.

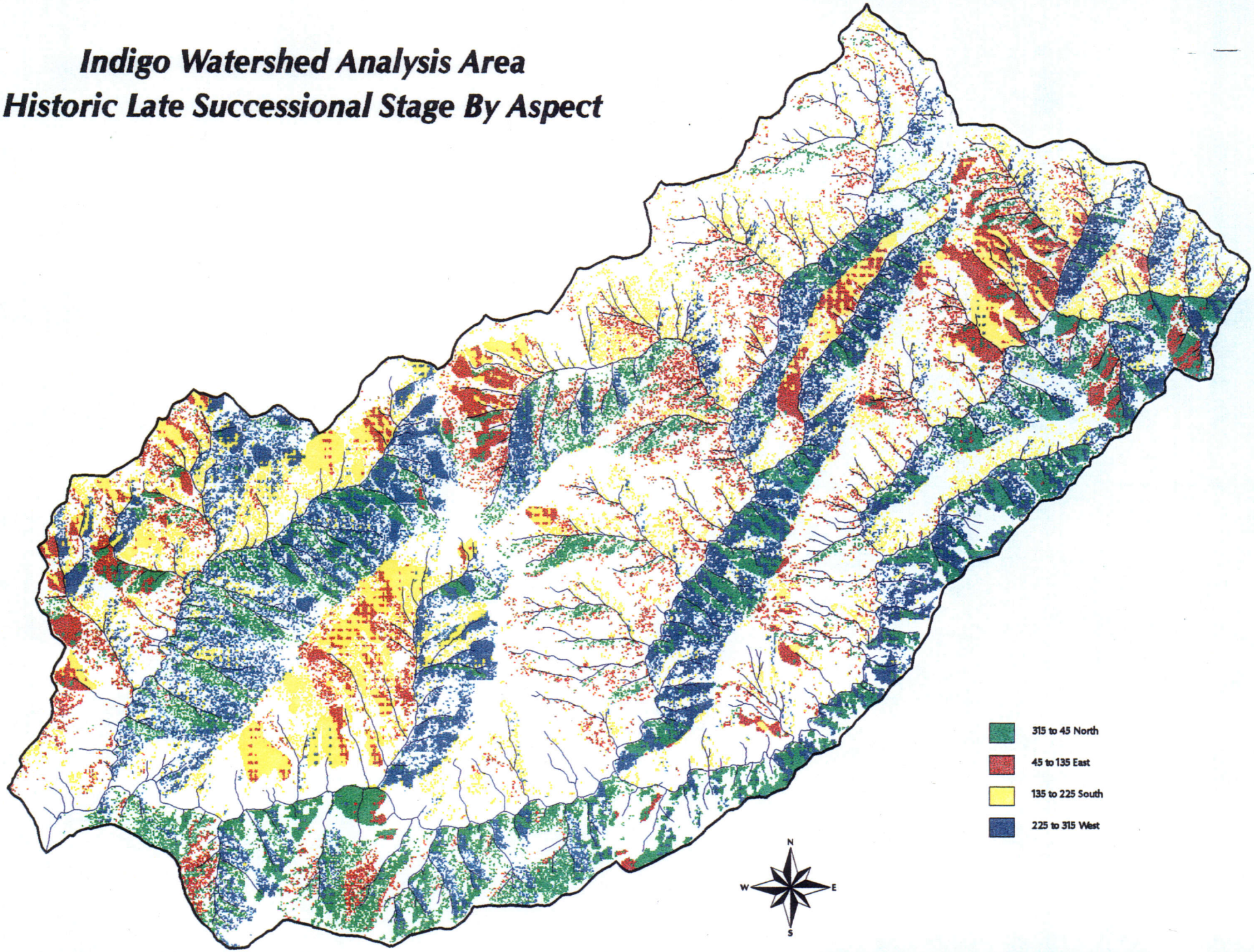
Indigo Watershed Analysis Area
Historic Timber Map 1950



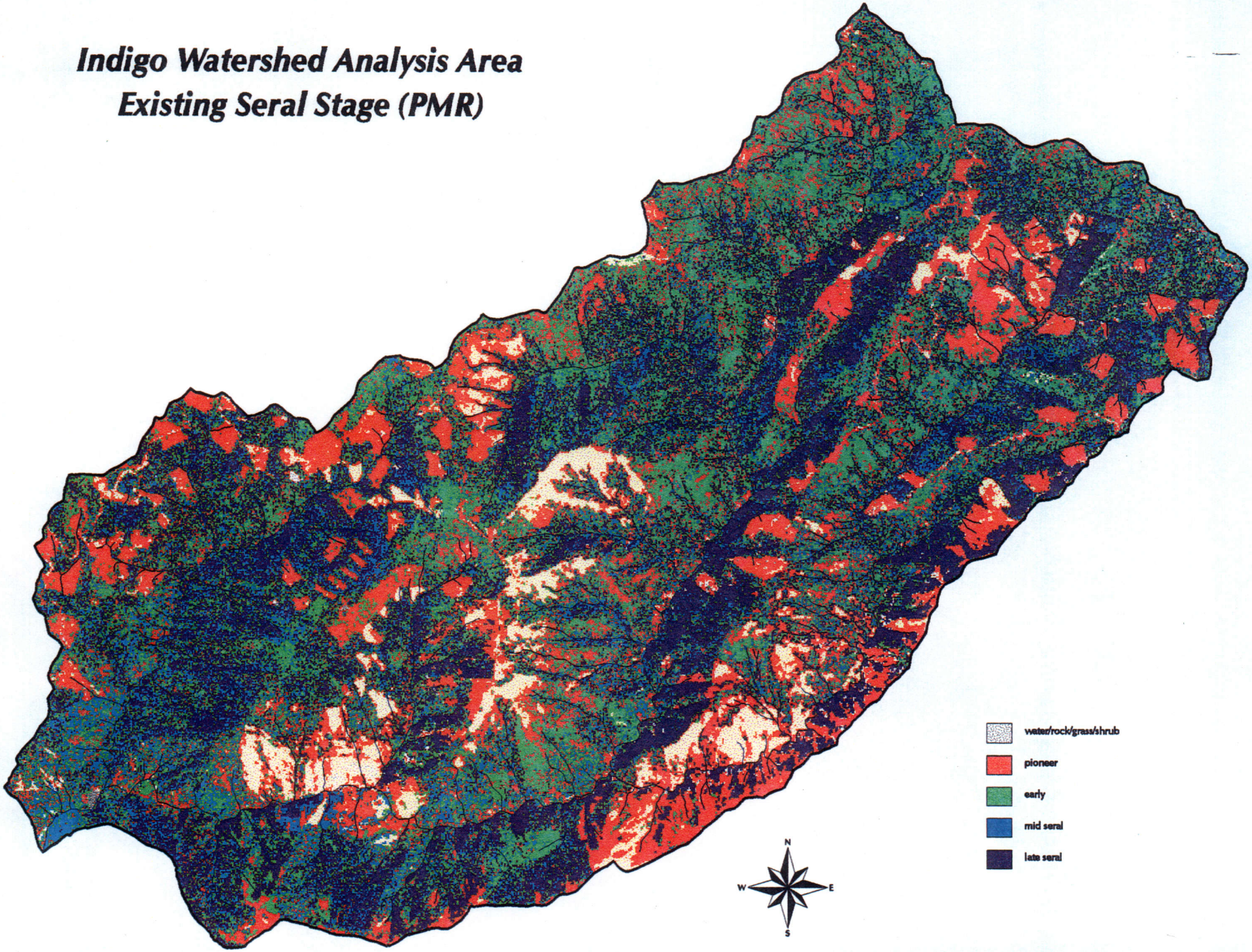
Indigo Watershed Analysis Area
Past History of Successional Stage



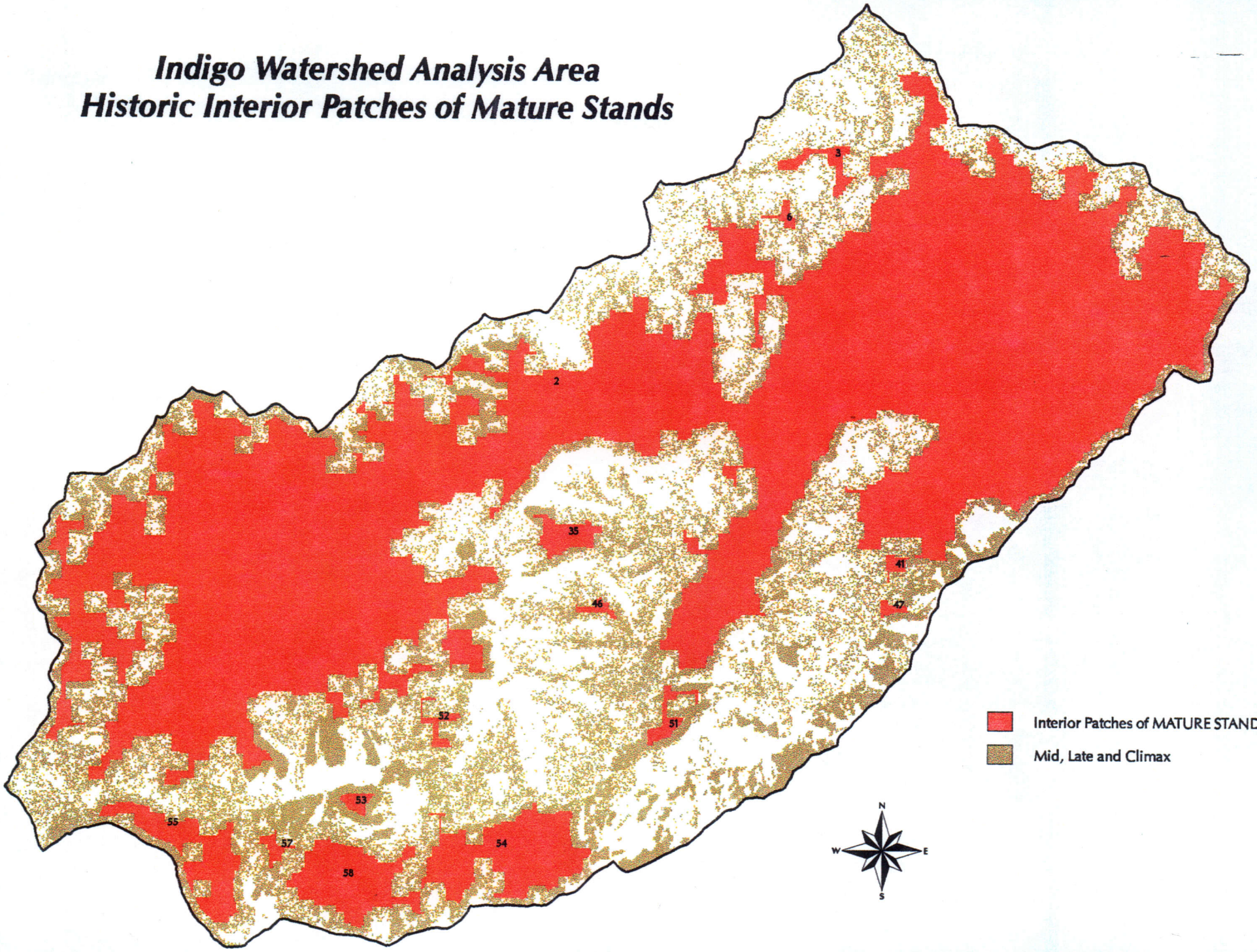
Indigo Watershed Analysis Area
Historic Late Successional Stage By Aspect

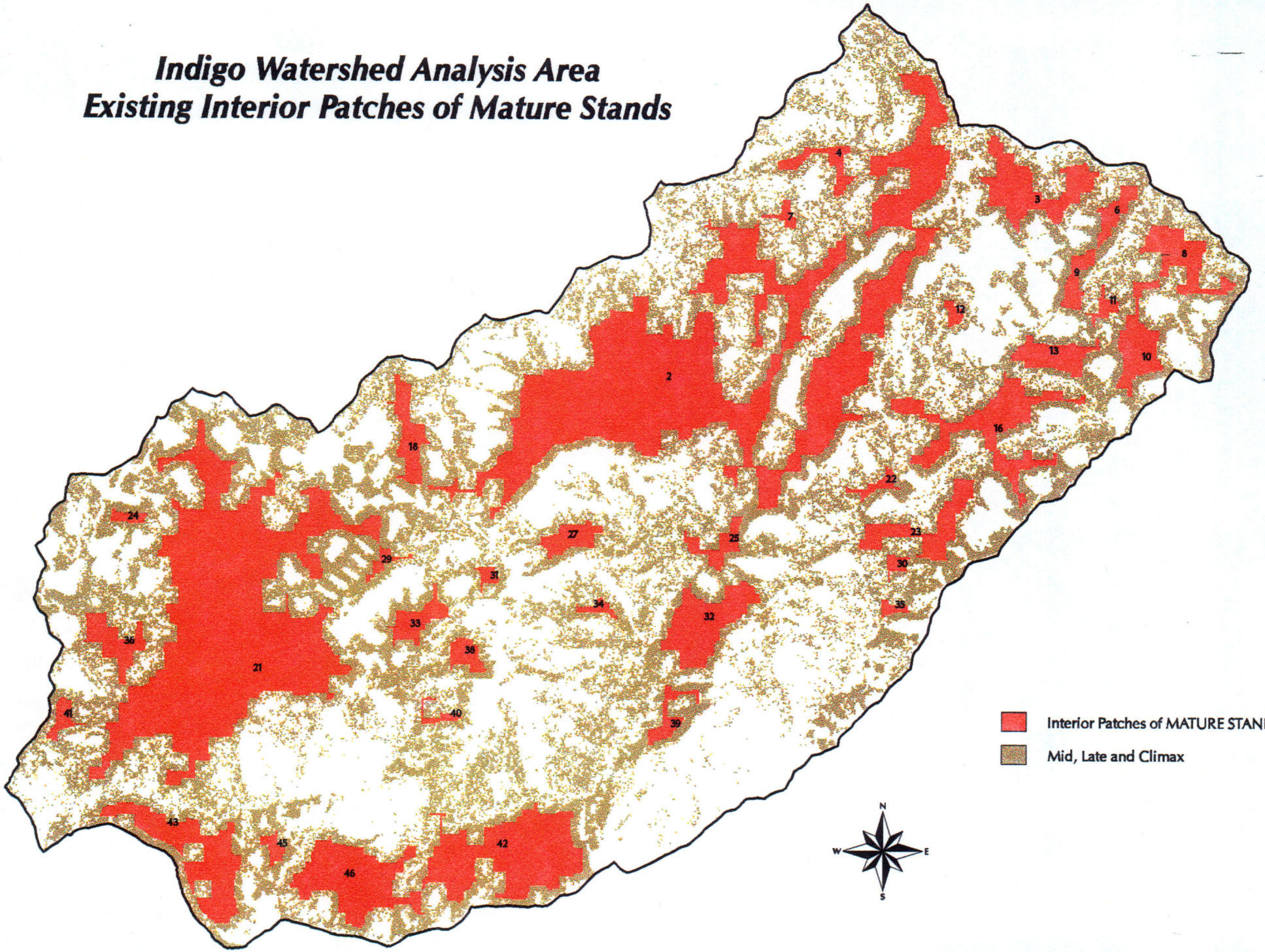


Indigo Watershed Analysis Area
Existing Seral Stage (PMR)



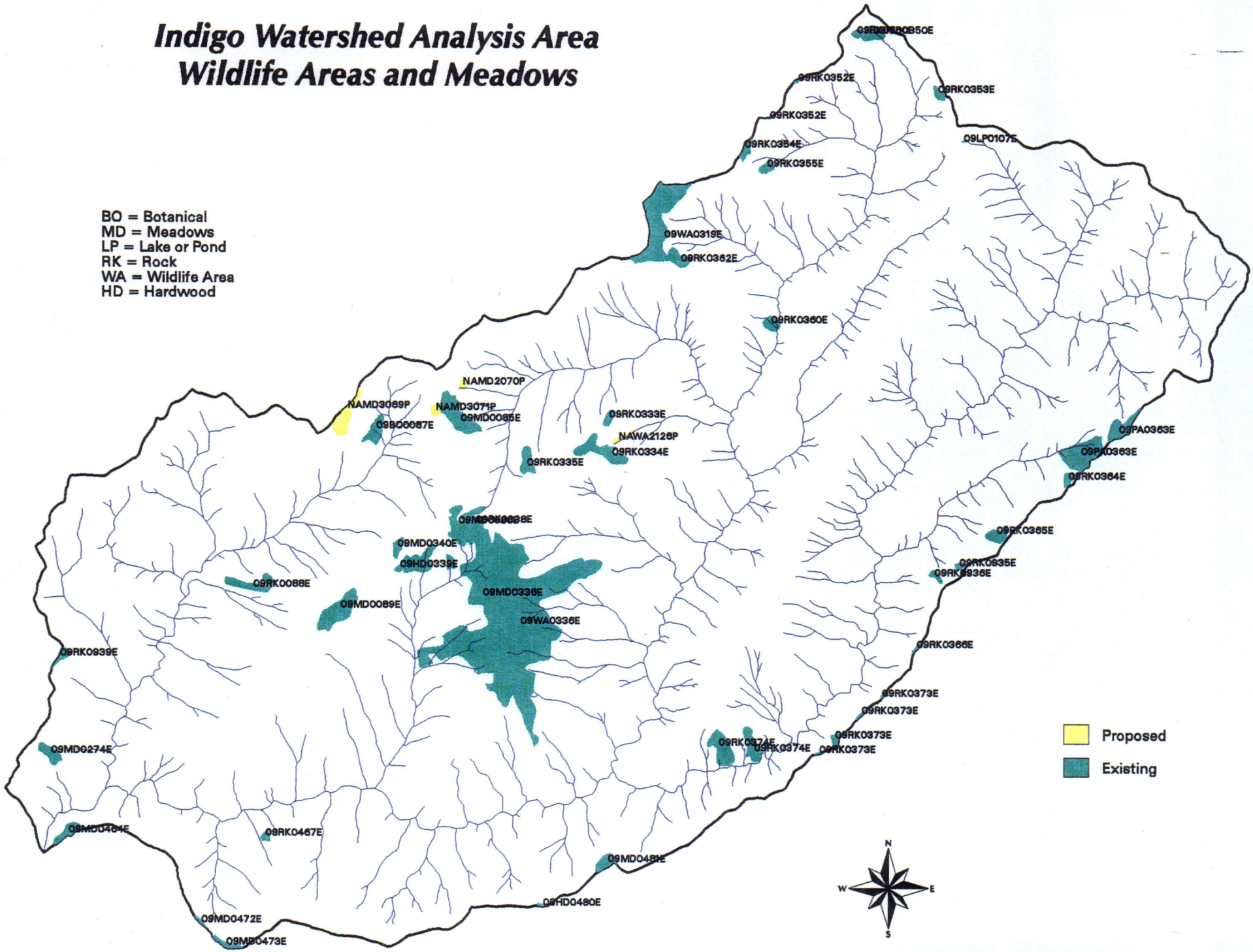
Indigo Watershed Analysis Area
Historic Interior Patches of Mature Stands



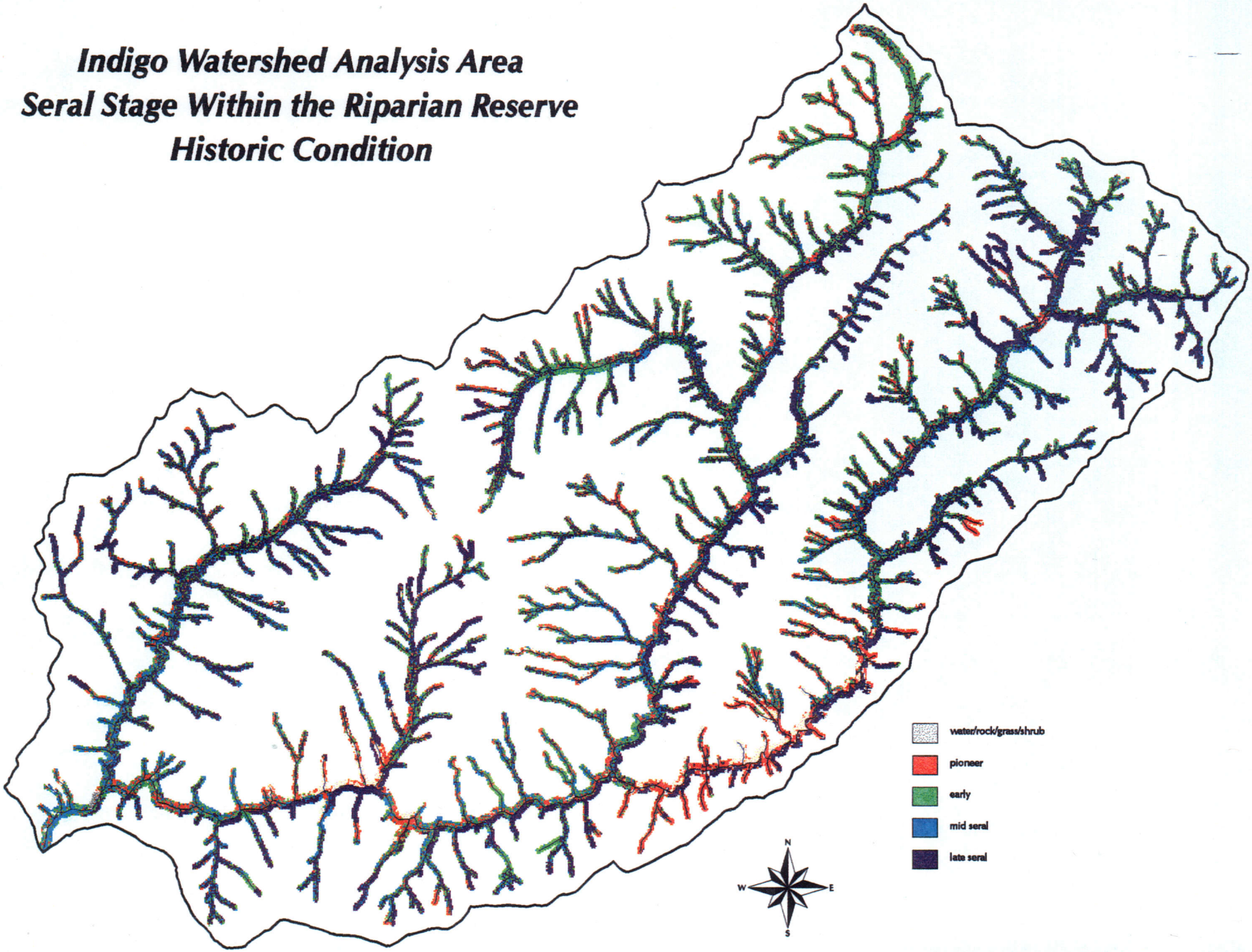

Indigo Watershed Analysis Area
Existing Interior Patches of Mature Stands
1
2
3
4
6
7
8
9
10
11
12
13
16
18
21
22
23
24
25
27
29
30
31
32
33
34
35
36
38
39
40
41
42
43
45
46
Interior Patches of MATURE STAND
Mid, Late and Climax
N
W
E
S

Indigo Watershed Analysis Area
Wildlife Areas and Meadows

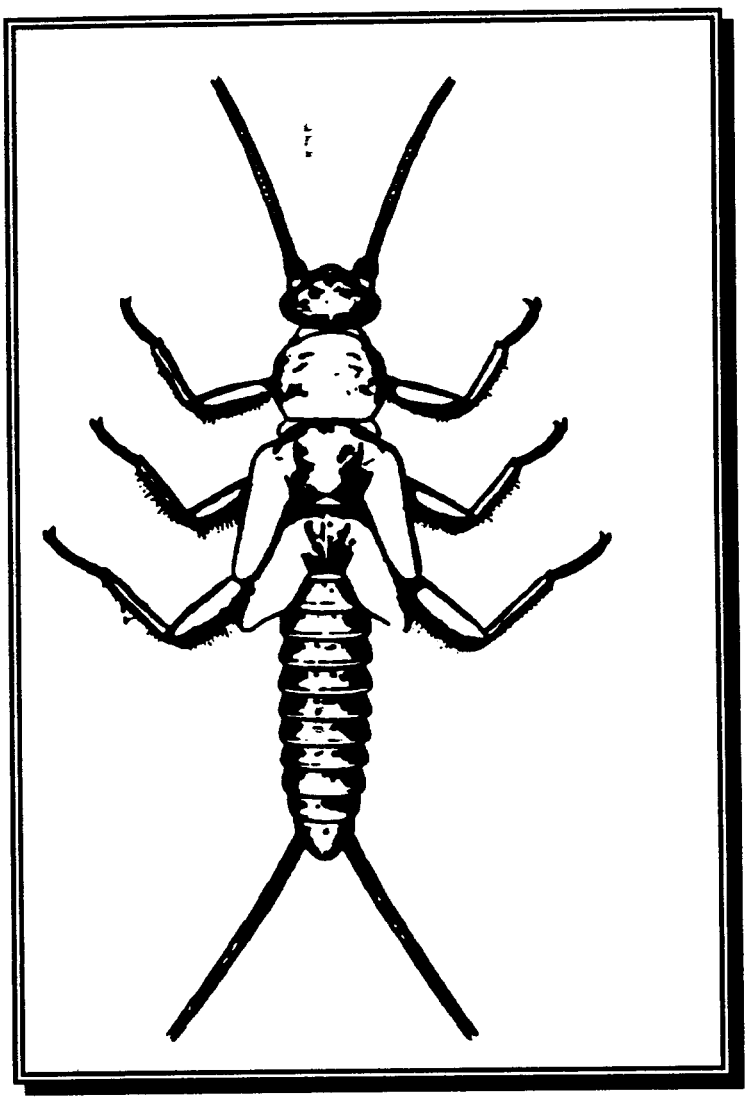
BO = Botanical
MD = Meadows
LP = Lake or Pond
RK = Rock
WA = Wildlife Area
HD = Hardwood



Indigo Watershed Analysis Area
Seral Stage Within the Riparian Reserve
Historic Condition



INDIGO CREEK WATERSHED ANALYSIS



APPENDIX B MACROINVERTEBRATE ANALYSIS AND TABLES

TABLE B1
BENTHIC SAMPLING LOCATIONS, YEAR, AND BIOASSESSOR

INDIGO BENTHIC MACROINVERTEBRATE SAMPLING			
Stream	**Location**	**Year(s)**	**Bioassessor**
Indigo Creek #1	500 yards upstream from confluence of NF Indigo	1988, 1989, 1990	FS Inter. Region Lab Provo, Utah
		1995	Cascades Environmental Services, Inc.
Indigo Creek #2	300 feet upstream from bridge at Illinois River Trail	1992	Aquatic Biology Associates, Inc.
East Fork Indigo Creek #1	200 feet upstream from confluence of WF Indigo	1988, 1989, 1990	FS Inter. Region Lab Provo, Utah
East Fork Indigo Creek #2	150 feet above confluence of Chief Creek	1991	Aquatic Biology Associates, Inc.
West Fork Indigo Creek #1	100 feet upstream from confluence of EF Indigo	1988, 1989, 1990	FS Inter. Region Lab Provo, Utah
West Fork Indigo Creek #2	150 feet upstream from confluence of Lazy Creek	1990	Aquatic Biology Associates, Inc.
Lazy Creek	200 feet above mouth	1990	Aquatic Biology Associates, Inc
Snail Creek	75 feet above mouth	1990	Aquatic Biology Associates, Inc
Breezy Creek	1/4 mile above mouth	1991	Aquatic Biology Associates, Inc
Chief Creek	100 feet above mouth	1991	Aquatic Biology Associates, Inc
North Fork Indigo Creek	100 feet above mouth	1995	Cascades Environmental Services, Inc.

Sampling results from the USDA Forest Service Intermountain Region Lab were different than the results from Aquatic Biology Associates due to sampling methodology. It is unknown what method was used to sample from 1988-1990. Cascades Environmental Services and Aquatic Biology Associates used the same methodology, ABA protocols, to sample from 1991-1995.

Results from the USDA Intermountain Region used three basic indexes: 1) biotic condition index (BCI) which indicates as a percentage how close an aquatic ecosystem is to its potential, 2) a species diversity index (DAT) which gives a measure of dominance and number of taxa, and 3) a standing crop index, see Table 2.

TABLE B2
RESULTS FROM USDA INTERMOUNTAIN REGION LAB FOR 1988-1990

STREAMS	BCI			DAT					
	1988	1989	1990	1988	1989	1990	1988	1989	1990
Indigo Creek #1	84	88	83	13.5	14.1	14.5	1.8	3.9	1.8
East Fork Indigo Creek #2	89	91	85	19.3	17	19.8	1.8	0.6	0.9
West Fork Indigo Creek #1	93	82	79	20.1	11.9	15.6	1.9	0.3	0.4

The following categories were used to identify the condition of sampled sites for years 1988-1990:

SCALE	BCI	DAT	STANDING CROP
Excellent	above 90	18 - 26	4.0 - 12.0
Good	80 - 90	11 - 17	1.6 - 4.0
Fair	72 - 79	6 - 10	0.6 - 1.5
Poor	below 72	0 - 5	0.0 - 0.5

No significant difference in the BCI (paired student T-test $p<0.5$) was observed between 1988, 1989, and 1990 for all streams monitored. Results in Table 8 indicate the macroinvertebrate community in Indigo basin was in good to excellent condition for those years sampled. These results may have been different if the ABA protocol was used.

The ABA protocol samples three stream habitats types (margin, riffle, CPOM-course particulate organic matter) to increase the scope of analysis of biotic and habitat integrity. Each of the three habitats is sampled in a non-random semi-quantitative manner targeting best available habitat present in the three habitat types. This provides a more robust look at the who's there/who's not there question.

Only the results from the riffle habitat type using the ABA protocol are seen in Table 3.
For the riffle habitat, a kiCreek-net was used to collect the insects which were then seived through a 500 mesh size and preserved in 95% ethanol. Samples were then processed in a lab and identified by qualified specialists and professionals.

Results from 1990-1995 using the ABA protocol are presented in four categories: 1) bioassessment score, 2) Shannon-Weiner Index, 3) Brillouin Index, 4) total taxa richness, and 5) Ephemeroptera (Mayflies) + Plecoptera (Stoneflies) + Trichoptera (Caddisflies) = EPT richness.

TABLE B3
RIFFLE HABITAT TYPE RESULTS USING ABA PROTOCOL FROM 1990 - 1995.

RIFFLE HABITAT												
SITES	BIOASSESSMENT SCORE % of *Max Score				DIVERSITY INDEX Shannon H`/Brillouin H				TL TAXA RICHNESS / EPT RICHNESS			
	1990	1991	1992	1995	1990	1991	1992	1995	1990	1991	1992	1995
Indigo Creek #1				51.6				2.85/2.80				45/19
Indigo Creek #2			47.2				2.83/2.71				54/25	
East Fork Indigo Creek #1												
East Fork Indigo Creek #2		65				3.44/3.40				70/36		
West Fork Indigo Creek #1												
West Fork Indigo Creek #2	46				2.08/2.78				46/23			
Lazy Creek	74				3.47/3.43				65/38			
Snail Creek	67				3.33/3.30				56/32			
Breezy Creek		71				3.49/3.45				71/42		
Chief Creek		78				3.53/3.51				80/44		
North Fork Indigo Creek				57.3				2.5/2.39				37/20

*Score based on a percentage of the maximum possible score. Max score is 69 for 1990-91 and 122 for 1992 & 1995.

Relevant Metrics

Diversity Indices - Both the Shannon-Weiner and Brillouin Diversity Indices are based on information theory. These indices are based on the rationale that the diversity, or information, in a natural system can be measured in a similar way to the information contained in a code or message. The value of the Shannon diversity index is usually found to fall between 1.5 and 3.5 and only rarely surpasses 4.5 (Magurran 1988). The Brillouin index also rarely exceeds 4.5. However, when the diversity of a particular data set is estimated using both indices the Brillouin index produces a lower result, as seen in Table 3. This is because there is no uncertainty in the Brillouin index: it describes a known collection. The Shannon index by contrast has to estimate the diversity of the unsampled as well as the sampled portion of the community. Stream invertebrate communities in non-impaired, forested, montane streams will typically have values >3. Nearly half of the sites sampled within Indigo basin from 1990-1995 had index values $\geq$ 3. Values above 3.4 are exceptionally high (positive indication). East Fork Indigo Creek #2, Lazy Creek, Breezy Creek, and Chief Creek exceeded this value and are considered to be very high in species diversity for those years sampled. Snail Creek has a good species diversity for 1990. Indigo Creek #1(1995 sample) and #2 (1992 sample) have moderate levels of species diversity for 1992. West Fork Indigo #2 and North Fork Indigo Creek have a low diversity for 1990 and 1995, respectively.

Richness - Taxa richness (number of discrete taxa) and EPT richness are directly correlated with habitat diversity and water quality. Total taxa richness in non-impaired streams that are very rich will occasionally exceed 70 taxa in riffle samples, and 30 in EPT richness. Many of the EPT taxa are some of the more intolerant aquatic invertebrates, though tolerant forms can also be found in these orders. For the sampled years East Fork Indigo Creek #2, Lazy Creek, Breezy Creek, and Chief Creek have high total taxa and EPT richness; Indigo Creek #2 and West Fork Indigo Creek #2 have moderate taxa and EPT richness; Snail Creek has a good level of total taxa and EPT taxa richness; Indigo Creek #1 has a moderate total taxa richness and low EPT richness; and North Fork Indigo Creek has the lowest taxa and EPT richness.

Density - The expected range of density or standing crop for assessing the biological integrity of benthic macroinvertebrate communities is at least $1000/m^2$. A value less than 500 may indicate very low productivity. All sites sampled were high in density with the exception of Indigo Creek #2 ($782/m^2$) and North Fork Indigo Creek ($476/m^2$), see Table 4. Extremely low densities indicate a harsh environment for invertebrates due to either low nutrient levels or physical factors. Very high densities can occur due to organic enrichment.

% Dominance - The expected range of a dominant taxa should be less than 15%. Percent dominant taxa is the % contribution of the most numerous taxa present in a sample. It is a simple measure of diversity. Stressed communities often are composed of not only fewer taxa, but also overwhelmed by a few tolerant and/or "weed" type taxa. High abundance of a single taxon indicates a stressed benthic community, which allows one or a few tolerant taxa to dominate the community. East Fork Indigo Creek #2, Lazy Creek, Snail Creek, Breezy Creek, and Chief Creek fell within the expected range. West Fork Indigo Creek #2, North Fork Indigo Creek, and Indigo Creek #1 have a moderate level of % dominant taxa. Indigo Creek #2 has a high % dominant taxa.

TABLE B4
DENSITY, % DOMINANT TAXA, AND YEAR SAMPLED

STREAMS	DENSITY m^2	DOMINANT TAXA	% DOMINANCE	YEAR
Indigo Creek #1	2280	*Antocha*	21.40	1995
Indigo Creek #2	782	*Simuliidae*	31.59	1992
East Fork Indigo #1	N/A	N/A	N/A	1988-1990
East Fork Indigo #2	4978	*Paraleptophlebia*	15.06	1991
West Fork Indigo #1	N/A	N/A	N/A	1988-1990
West Fork Indigo #2	5502	*Hydropsyche*	22.43	1990
Lazy Creek	4169	Oligochaeta	10.40	1990
Snail Creek	4408	Oligochaeta	11.73	1990
Breezy Creek	5661	Oligochaeta	11.78	1991
Chief Creek	7907	Oligochaeta	11.48	1991
North Fork Indigo Creek	476	*Baetis tricaudatus*	18.98	1995

Oligochaeta was the dominant taxa for Lazy Creek, Snail Creek, Breezy Creek, and Chief Creek. Oligochaet worms thrive in habitats where organic rich fine sediment has built up. Some taxa are extremely tolerant. High numbers in montane riffles (which normally have the least sediment) is usually a negative sign, indicating excessive fines. However, numbers can build up in spring-fed systems where a more constant annual hydrograph and infrequent floods allows poCreekets of fine sediment to accumulate.

Baetis tricaudatus is the dominant taxa found in North Fork Indigo Creek. Although it is an ephemeropteran, referred to as one of the cold-water families, certain characteristics of this species reflects disturbance. *Baetis tricaudatus* is ubiquitous in pacific northwest streams and rivers with a wide habitat range. It is replaced with *bicaudatus* at higher elevations and in colder streams. This species is relatively tolerant, a behavioral drifter, and colonizes disturbed habitats rapidly.

Paraleptophlebia is dominant in East Fork Indigo Creek #2. This species is widespread in the pacific northwest and short-lived. It is capable of tolerating some disturbance. *Paraleptophlebia* is a collector feeder, meaning it collects suspended particles.

Antocha is the dominant taxa found in Indigo Creek #1. *Antocha* is a common species in the pacific northwest. It is found inside silken tubes attached to roCreeks, plant, and debris and collects suspended particles as well.

Simuliidae are blaCreek flies. Indigo Creek #2 had a high percent contribution of this species. They are a normal component of almost all montane streams. High densities of these larvae are usually associated with disturbd or enriched streams.

Hydropsyche is dominant in West Fork Indigo Creek #2 and is common in the pacific northwest. It too is a collector feeder, indicating a good source of suspended particles for food.

Collector feeding organisms use a variety of adaptations to capture fine organic particles suspended in the water column. In mid-order, well shaded streams, the number of filterers is usually low. Numbers increase when shading decreases or when the amount of fine particulate organic matter increases.

In summary, no trend can be identified from 1990 - 1995 due to inconsistency of sampling at each stream. Each site was only sampled one year, with the exception of 1988-1990 samples which included only 3 sites. Data from 1988 - 1990 can establish beginning trend conditions. Existing data can only serve as baseline information and site-specific information. Results of scores may also be nebulous at a watershed scale but beneficial for immediate site condition.

Further sampling at a semi-annual basis on same locations may help further clarify any trends or patterns. In addition, because there were 2 different protocols used (Intermountain Region and ABA) there is an apparent subjective assessment. Results from Intermountain Region were expressed differently than the results using the ABA protocol. Conditions of subwatersheds presented here show a pattern in deposited fines through macroinvertebrate community characteristics.

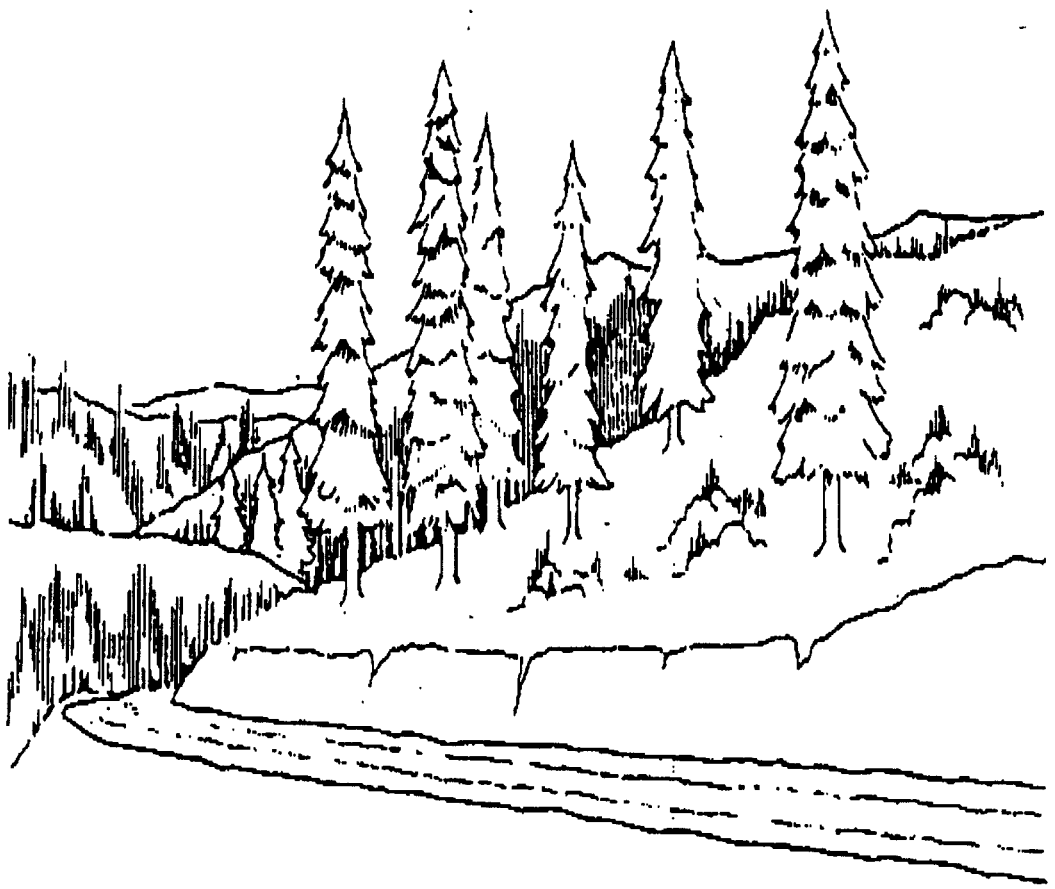
TABLE B5
BIOASSESSMENT SCORES OF STREAMS SAMPLED FROM 1990 – 1995

(Using the ABA Protocol)

	90 - 100 %	**Very High**
	80 - 89%	**High**. *High* habitat complexity, biotic integrity, taxa richness, % of cool adapted fauna, number of more specific microhabitat related taxa, etc. *Low* numbers of highly tolerant taxa.
EF Indigo #2, Lazy Creek, Snail Creek, Breezy Creek, and Chief Creek	**60 - 79%**	**Moderate**. *Moderate* as above. The benthic invertebrate community points to some habitat limitations.
Indigo Creek #1 and #2, WF Indigo Creek #2, and NF Indigo Creek	**40 - 59%**	**Low**. *Low* as above. The community reflects significant habitat and/or water quality limitations.
	<40%	**Severe**. The community present has developed under habitat conditions that represent a severe departure from the ideal conditions.

1) The bioassessment score is a total score expressed as % maximum possible score.

INDIGO CREEK WATERSHED ANALYSIS



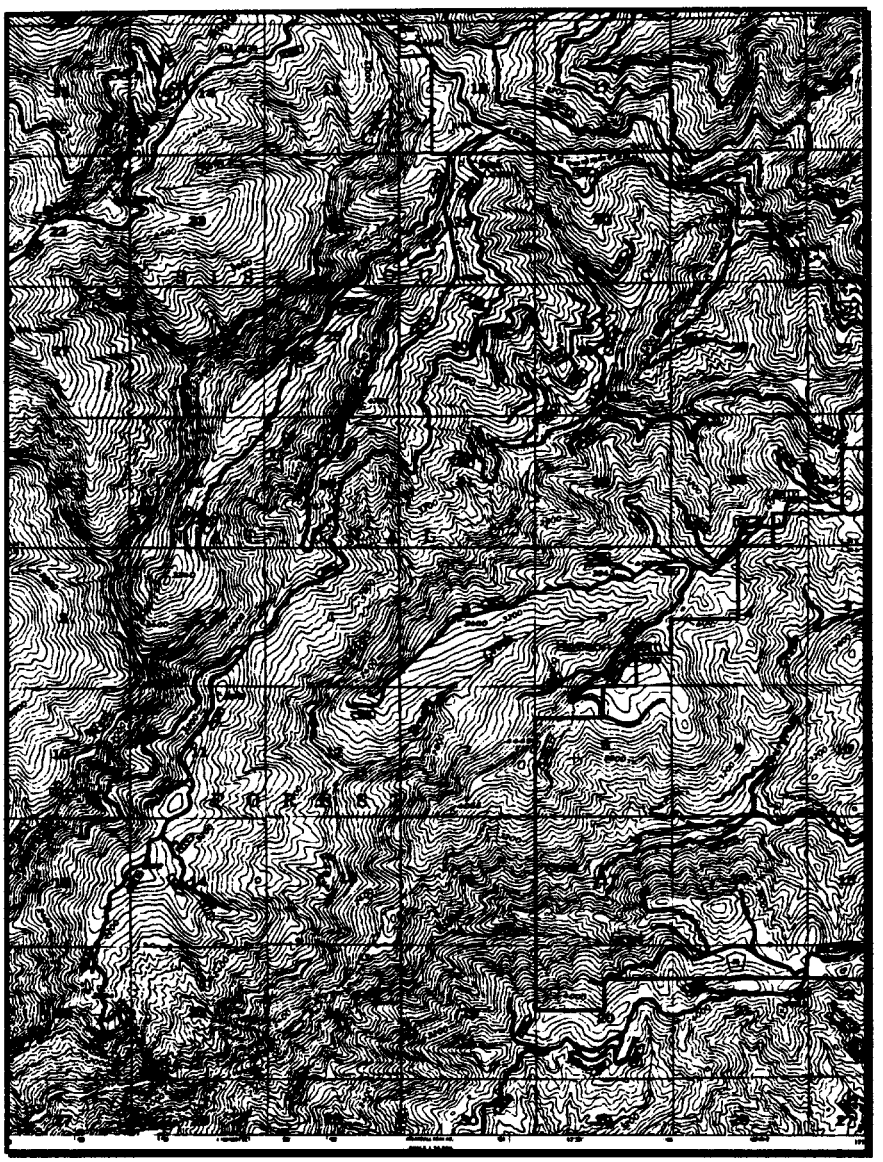
APPENDIX C
CANDIDATE ROADS

TRANSPORTATION NETWORK ANALYSIS
CANDIDATE ROADS FOR DECOMMISSIONING IN INDIGO CREEK WATERSHED

ROAD NUMBER	LENGTH[1]	ROAD NAME
2300407	0.25	Fork Spur
2300408	1.20	East Chief
2300415	1.75	Buck Creek
2300416	1.21	Chief Buck
2300448	0.39	Crusher Road
2300449	0.73	Lake Ridge
2300451	1.32	Lazy Buck
2300455	0.13	Haystack
2308475	0.72	Snail Basin A-Spur
2308478	0.38	Snail Basin B-Spur
2308483	0.12	Snail Basin F-Spur
2308488	0.45	Snail Basin D-Spur
2308505	0.20	Snail Basin E-Spur
2308520	0.65	Sugar E Spur
2411502	0.30	Log Spruce
3577040	0.18	Gooseberry
3577090	0.13	Kayberry
3577130	1.28	Redberry
3577133	0.83	Shoo
3577135	1.19	Violet
3577260	1.32	Blue
3577350	0.32	Buzzardberry
TOTAL	15.05 Miles	

1) Road Miles are those miles that fall within the Indigo Watershed. Total road miles of decommissioning may be greater by the mileage outside of the Indigo Watershed than that indicated for specific roads.

INDIGO CREEK WATERSHED ANALYSIS



APPENDIX D
AQUATIC MODULE TABLES

TABLE D1
RIPARIAN VEGETATION SERAL STAGES BY SUBWATERSHED

Subwatersheds				
Seral Stage	**Indigo Mainstem**	**North Fork**	**West Fork**	**East Fork**
Rock	16	5	11	40
Grass	8	0	0	0
Shrub	127	10	35	147
Rock/Grass/Shrub	151	15	46	187
Pioneer	512	294	655	961
Early	513	356	1253	784
Mid	514	412	758	564
Late	718	694	1366	1099
Climax	2408	1771	4078	3595

TABLE D2
PERCENTAGE RIPARIAN VEGETATION SERAL STAGES BY SUBWATERSHED

	Percentages			
Rock/Grass/Shrub	6	1	1	5
Pioneer	21	17	16	27
Early	21	20	31	22
Mid	21	23	19	16
Late	30	39	33	31

TABLE D3
HILLSLOPE CLASSES FOR ROADS BY SUBWATERSHED

	Road Miles by Slope			
	Indigo	**North Fk**	**West Fk**	**East Fk**
0-10 %	0.26	0.92	1.18	1.93
11-30	7.89	14.2	11.1	14.25
31-50	3.28	15.3	13.0	19.76
51-70	1.04	2.84	4.97	8.23
71-90	0.16	0.07	0.41	0.80
Total	12.6	33.4	30.7	44.97

TABLE D4
LANDSLIDE VOLUMES, 1940 – 1988
(WITHIN THE SILVER FIRE OF 1987)

WS	LS #	Site Cond	WS Sens	Geo	% Slope	Aspect	Landform	Slide Type	Slope Shape	Depth (ft)	Slope length (ft)	Width (ft)	Slope Location	Vol Failed (cy)	Deliv %	Deliv Vol (cy)	Deliv Calc Vol	Monitored	Fire Intensity	SRI	Early Date	Late Date	Pre 8-40	9-56/9-57	9-64	9-69	9-73	10-87	8-88
wi	25	P	H	JD	75	S	HW	DS	V	12	20	75	H	11300	1	100	113		M		1964	1969				E	N	N	
wi	26	R	H	JD	65	NW	DC	DS	V							0	0		L		1900	1940	P	N	N	R	N	N	
wi	26	R	H	JD	65	NW	DC	DS		6	19	80	G	341	5	170	170				1964	1969				R			
wi	25	U	M	JD	55	SE	HW	DS	V							0	0		M		1900	1940	V	N	N		N	N	
ei	26			JRGV													0				1900	1940	P	N	N		N	N	
ei	26			JRGV													0				1900	1940	P	N	N		N	N	
ei	16	N	H	JD	10	S	IG	DS	V	15	42	15	G	60000	9	57000	57000		M		1957	1964			E	N	N	N	
ei	23	N	M	JD	60	W	IG	DS	V							0	0		L		1900	1940	V	N	N		N	N	
ei	23	N	H	JRGV	60	E	IG	DS	P	10	20	10	G	12500	9	11900	11875		M		1964	1969	V	N	N	R	N	N	
ei	23	P	H	GB	75	S	IG	DS	V							0	0		L		1900	1940	V	N	N		N	N	
ei	16	U	H	JD	90	N	DC	DS	V							0	0		H		1900	1940	V	N	N		N	N	
ei	16	U	H	JD	60	S	IG	DS	P	3	50	20	G	560	9	177	532		M		1957	1964			E	N	N	N	
ei	18	U	H	GB	75	NW	DC	RF	V							0	0		H		1900	1940	V	N	N		N	N	
ei	18	U	H	GB	50	E	IG	DS	V							0	0		L		1900	1940	V	N	N		N	N	
ei	23	U	L	GB	75	W	IG	DS	P							0	0		M		1900	1940	P	N	N		N	N	
i	24	C	H	JD	75	NW	DC	DS	V							0	0		L		1900	1940	P	N	N		V	N	
i	10	N	H	JD	70	N	DC	DT	V							0	0		L		1900	1940	V	N	N	N	N	N	
i	11	N	H	JD	65	N	HW	DT	V							0	0		H		1900	1940	P	N	N		N	N	
i	12	N	H	JD	75	SW	DC	DS	V							0	0		L		1900	1940	P	N	N		N	N	
i	13	N	H	JD	75	NW	HW	DS	V							0	0		M		1900	1940	V	N	N		N	N	
i	13	N	L	JD	60	NW	HW	DS	V							0	0		H		1900	1940	V	N	N		N	N	
i	13	N	H	JD	60	NW	DC	DS	V	12	30	40	M	704	9	630	633		L		1900	1940	P	N	N		N	N	
i	13	N	H	JD	10	S	IG	DS		12	19	75	G	10700	9	960	963				1973	1987						R	
i	13	N	H	JD	10	S	IG	DS	X							0	0		L		1900	1940	V	N	N		N	R	N
i	14	N	H	JD	85	NE	IG	DS	V							0	0		L		1900	1940	V	N	N		N	N	
i	14	N	H	JD	50	NE	IG	DS	V							20000	0		L		1940	1956	V	R	N		N	N	
i	15	N	H	JD	90	NW	IG	DS								0	0				1900	1940	V	N	N		N	R	N
i	15	N	H	JD	90	NW	IG	DS	X	6	17	70	G	446	9	400	402		L		197	1987						R	
i	15	N	H	JD	90	NW	IG	DS	X	9	10	50	G	280	9	250	252		L		1900	1940	V	N	N		N	N	
i	15	N	M	JD	85	E	HW	DS	V							0	0		L		1900	1940	V	N	N		N	N	

WS	LS #	Site Cond	WS Sens	Geo	% Slope	Aspect	Landform	Slide Type	Slope Shape	Depth (ft)	Slope length (ft)	Width (ft)	Slope Location	Vol Failed (cy)	Deliv %	Deliv Vol (cy)	Deliv Calc Vol	Monitored	Fire Intensity	SRI	Early Date	Late Date	Pre 8-40	9-56/9-57	9-64	9-69	9-73	10-87	8-88
i	15	N	H	JD	55	E	HW	DS	P	6	15	30	G	169	3	50	50		L		1900	1940	V	N	N		N	N	
i	15	N	H	JD	90	N	IG	DS	V							0	0		L		1900	1940	V	N	N		N	N	
i	15	N	H	TS	10	N	IG	DS	V							0	0		L		1900	1940	V	N	N		N	N	
i	15	N	H	JD	75	NE	IG	DS	V	8	17	70	G	600	8	480	480		L		1973	1987						E	N
i	17	N	H	JD	90	NW	IG	DS	X	12	10	10	G	750	9	700	712		L		1957	1964			E		N	N	
i	17	N	H	JD	75	S	IG	DS	V							0	0		L		1900	1940	V	N	N		N	N	
i	17	N	H	JD	90	S	IG	DS	V							0	0		L		1900	1940	V	N	N		N	N	
i	17	N	H	JD	10	S	IG	DS	V							0	0		L		1900	1940	V	N	N		N	N	
i	17	N	H	JD	10	NW	IG	DS	V							0	0		L		1900	1940	V	N	N		N	N	
i	17	N	H	JD	60	SW	DC	DS	P							0	0		L		1900	1940	V	N	N		N	N	
i	17	N	H	MG	75	S	IG	DS	V							0	0		L		1900	1940	V	N	N		N	N	
i	18	N	H	MG	50	N	IG	DS	V							0	0		L		1900	1940	V	N	N		N	N	
i	18	N	H	MG	50	S	IG	DS	P							0	0		L		1900	1940	P	N	N		V	N	
i	19	N	H	JD	10	SE	HW	DS	P							0	0		L		1900	1940	V	N	N		N	N	
i	19	N	H	JD	10	S	IG	DS	P							0	0		H		1900	1940	P	N	N		N	N	
i	19	N	H	JD	75	S	IG	DS	P							0	0		M		1900	1940	P	N	N		N	N	
i	19	N	H	JD	80	SE	DC	DT	V							0	0		L		1900	1940	P	N	N		N	N	
i	19	N	H	JD	75	S	IG	DS	P							0	0		L		1900	1940	V	N	N		N	N	
i	19	N	H	JD	90	S	IG	DS	P							0	0		L		1964	1969	V	N	N	R	N	N	
i	19	N	H	JD	75	S	IG	DS	V	8	10	25	G	125	10	120	125		L		1969	1973	V	N	N		E	N	
i	19	N	H	JD	60	NW	IG	DS	X	12	20	10	G	15000	9	14000	14250		L		1973	1987						E	N
i	20	N	H	JD	60	SE	DC	DT	V							0	0		M		1964	1969				E	N	V	
i	20	N	H	JD	60	NE	IG	DS	P	15	20	10	G	19000	10	19000	19000		L		1900	1940	V	N	N		N	N	
i	21	N	H	JD	10	SE	IG	DS	V							0	0		L		1964	1969				E	N	N	
i	21	N	H	JD	90	SE	DC	DS	V							0	0		L		1900	1940	V	N	N		N	N	
i	21	N	H	JD	90	SE	DC	DS	V							0	0		M		1900	1940	V	N	N		N	N	
i	21	N	H	JD	60	SE	HW	DS	V							0	0		M		1900	1940	V	N	N		N	N	
i	21	N	H	JD	75	SE	HW	DS	V							0	0		M		1900	1940	V	N	N		N	N	
i	21	N	H	JD	85	SW	HW	DS	P							0	0		M		1900	1940	V	N	N		N	N	
i	21	N	H	JD	85	SW	HW	DS	P							0	0		L		1900	1940	P	N	N		N	N	
i	21	N	M	JD	90	SW	HW	DS	P							0	0		L		1900	1940	P	N	N		N	N	
i	21	N	H	JD	60	W	IG	DS	X							0	0		M		1900	1940	V	N	N		N	N	
i	21	N	H	JD	50	E	IG	DS	P							0	0		M		1900	1940	V	N	N		N	N	
i	21	N	H	JD	50	E	IG	DS		6	23	80	G	691	9	621	656				1900	1940	P	N	N	R	N	N	
																					1964	1969				R			

WS	LS #	Site Cond	WS Sens	Geo	% Slope	Aspect	Landform	Slide Type	Slope Shape	Depth (ft)	Slope length (ft)	Width (ft)	Slope Location	Vol Failed (cy)	Deliv %	Deliv Vol (cy)	Deliv Calc Vol	Monitored	Fire Intensity	SRI	Early Date	Late Date	Pre 8-40	9-56/9-57	9-64	9-69	9-73	10-87	8-88
i	22	N	M	JD	75	W	IG	DS	P	6	14	40	G	210	9	200	199		M		1964	1969				E	N	N	
i	22	N	M	JD	55	E	IG	DS	P							0	0		M		1900	1940	P	N	N		N	N	
i	22	N	H	JD	85	W	IG	DS	X	6	17	30	G	200	10	200	200		L		1973	1987						E	N
i	22	N	H	JD	60	W	IG	DS		15	25	10	G	23500	9	23000	22325				1964	1969				R			
i	22	N	H	JD	60	W	IG	DS	P							0	0		M		1900	1940	P	N	N	R	N	N	
i	22	N	H	JD	60	E	IG	DS	P	6	40	80	G	12000	9	11400	11400		M		1964	1969				E	N	N	
i	22	N	H	JD	90	W	IG	DS	P	9	10	10	G	560	9	540	532		L		1964	1969				E	N	V	
i	22	N	H	GB	75	S	IG	DS	P	15	20	10	G	19000	10	19000	19000		L		1957	1964			E	N	N	N	
i	22	N	H	GB	75	S	IG	DS	P	12	15	50	G	560	10	560	560		L		1964	1969				E		N	
i	23	N	H	GB	75	S	IG	DS	P	12	15	50	G	560	10	560	560		L		1964	1969				E		N	
i	23	N	H	JD	90	W	IG	DS	P							0	0		L		1900	1940	V	N	N		N	N	
i	23	N	H	JD	90	SE	IG	DS	V	10	15	50	G	500	10	500	500		L		1964	1969				E	N	N	
i	23	N	H	JD	65	W	DC	DS	V							0	0		L		1900	1940	V	N	N		N	N	
i	23	N	H	JD	90	NW	IG	DS	P	10	20	60	G	750	9	0	675		L		1900	1940	V	N	N	N	N	N	
i	23	N	H	JD	65	SE	IG	DS	P	10	40	20	G	50000	10	50000	50000		L		1964	1969				E	N	N	
i	24	N	H	JD	90	SE	IG	DS	V	10	40	20	G	50000	10	50000	50000		L		1964	1969	V	N	N	R	N	V	
i	24	N	H	JD	75	NW	IG	DS	V							0	0		L		1900	1940	V	N	N		N	N	
i	24	N	H	JD	10	NW	IG	DS	V							0	0		L		1900	1940	V	N	N		N	N	
i	24	N	H	JD	65	SE	IG	DS	V	15	40	40	G	15000	9	14300	14250		L		1964	1969	V	N	N	R	N	V	
i	24	N	H	JD	10	NW	IG	DS	V				G			0	0		L		1900	1940	P	N	N	R	N	N	
i	24	N	H	JD	10	NW	IG	DS		15	26	14				10000	0				1964	1969				R			
i	24	N	H	JD	55	SE	IG	DS	P	12	20	15	G	22500	10	22500	22500		L		1940	1957		E 1957	N		N	N	
i	25	N	H	JD	55	SE	IG	DS	P	9	14	60	G	480	10	480	480		L		1964	1969				E	N	N	
i	25	N	H	JD	55	NE	IG	DS									14250				1964	1969				R 75			
i	25	N	H	JD	55	NE	IG	DS	P	20	10	10	G	12500	10	12500	475		L		1940	1956		E 25		R 75	N	V	
i	25	N	H	JD	70	NW	IG	DS	X	12	10	10	G	750	1	75	75		L		1973	1987						E	N
i	25	N	H	JD	80?	SE	IG	DS	V							0	0		L		1940	1956		E	N		N	N	
i	26	N	H	JD	80?	NW	IG	DS	X							0	0		L		1940	1956		E	N		N	N	
i	26	N	H	JD	80	NE	IG	DS	V							10000	10000		L		1964	1969				E	N	N	
i	12	P	H	JD	60	N	DC	DT	V							0	0		L		1900	1940	V	N	N		N	N	
i	12	P	H	JD	75	S	HW	DS	X							0	0		L		1900	1940	P	N	N		N	N	
i	14	P	H	JD	10	NE	HW	DS	V							0	0		L		1900	1940	V	N	N		N	N	
i	14	P	M	JD	60	N	HW	DS	V							0	0		L		1900	1940	V	N	N		N	N	

WS	LS #	Site Cond	WS Sens	Geo	% Slope	Aspect	Landform	Slide Type	Slope Shape	Depth (ft)	Slope length (ft)	Width (ft)	Slope Location	Vol Failed (cy)	Deliv %	Deliv Vol (cy)	Deliv Calc Vol	Monitored	Fire Intensity	SRI	Early Date	Late Date	Pre 8-40	9-56/9-57	9-64	9-69	9-73	10-87	8-88
i	15	P	H	JD	75	NE	HW	DS	P							0	0		M		1900	1940	V	N	N		N	N	
i	24	P	H	JD	60	SE	DC	DS	V							0	0		L		1900	1940	V	N	N		N	N	
i	24	P	H	JD	10	SW	DC	DS	V							0	0		M		1900	1940	V	N	N		N	N	
i	25	P	H	JD	60	E	DC	DS	V							0	0		M		1900	1940	V	N	N		N	N	
i	12	U	H	JD	75	N	HW	DS	V	9	70	20	M	616	9	600	585		M		1900	1940	P	N	N		N	N	
i	15	U	H	JD	10	NW	HW	DS	P							0	0		M		1900	1940	V	N	N		N	N	
i	16	U	H	JD	55	N	DC	DS	V	9	40	40	G	90	9	0	85		M		1900	1940	V	N	N		N	N	
i	17	U	H	JD	90	S	IG	DS	P							0	0		M		1900	1940	V	N	N		N	N	
i	17	U	H	JD	90	S	IG	DS	P							0	0		M		1900	1940	V	N	N		N	N	
i	19	U	H	JD	90	SW	IG	DS	V							0	0		L		1900	1940	V	N	N		N	N	
i	19	U	H	JD	55	SE	IG	DS	V	8	20	50	G	500	9	480	475		M		1964	1969	V	N	N	R	N	N	
i	20	U	H	JD	60	S	IG	DS	V							0	0		M		1900	1940	V	N	N		N	N	
i	20	U	H	JD	60	S	IG	DS	V							0	0		M		1900	1940	V	N	N		N	N	
i	20	U	H	JD	75	S	DC	DT	P	6	25	50	G	470	1	47	47		H		1964	1969				E	N	N	
i	20	U	H	JD	75	S	IG	DS	P							0	0		M		1900	1940	P	N	N		N	N	
i	20	U	H	JD	90	S	IG	DS	V							0	0		M		1900	1940	V	N	N		N	N	
i	20	U	H	JD	75	E	IG	DS	P	12	13	10	G	980	9	930	931		M		1964	1969				E	N	N	
i	20	U	H	JD	75	S	IG	DS	P							0	0		M		1900	1940	V	N	N		N	N	
i	20	U	H	JD	10	S	IG	DS	P							0	0		M		1900	1940	P	N	N		N	N	
i	24	U	H	JD	10	W	IG	DS	V							0	0		L		1900	1940	V	N	N		N	N	
ls	14	P	H	GB	75	S	IG	RF	V								0		L		1900	1940	P	N	N		N	N	
ls	44	U	H	GB	60	E	DC	DS	V	20	35	60	M	20200	8	16000	16160		M	19	1964	1969				E	N	N	
ns	15		M	GB	95	SE	IG	DS									100				1973	1987						R 50	
ns	14	N	M	GB	75	NW	HW	RF	V								0		L		1900	1940	P	N	N		N	N	
ns	15	N	M	GB	95	SE	IG	DS	V				G		10	200	100		L		1957	1964			E 50		N	R 50	N
ns	16	N	M	GB	75	NW	IG	DS	P							0	0		L		1900	1940	V	N	N		N	N	
ns	17	N	M	JD	75	W	HW	DS	V							0	0		L		1900	1940	V	N	N		N	N	
ns	18	N	H	GB	75	N	HW	DS	V							0	0		L		1900	1940	P	N	N		N	N	
ns	18	N	H	GB	75	S	HW	DS	V							0	0		L		1900	1940	P	N	N		N	N	
ns	22	N	M	GB	60	SE	IG	DS	V							0	0		M		1900	1940	V	N	N		N	N	
ns	22	N	M	GB	75	SE	HW	DS	V							0	0		L		1900	1940	P	N	N		N	N	
ns	25	N	M	JRGV	85	SE	IG	DS	P				G		10	100	0		M		1940	1956		E	N		N	N	
ns	14	P	H	JD	65	SE	IG	DS	V	20	35	10	G	44000	9	40000	0		M		1964	1969				E 60	N	R 40	
ns	14	P	H	JD	65	SE	IG	DS									0				1973	1987						R 40	

WS	LS #	Site Cond	WS Sens	Geo	% Slope	Aspect	Landform	Slide Type	Slope Shape	Depth (ft)	Slope length (ft)	Width (ft)	Slope Location	Vol Failed (cy)	Deliv %	Deliv Vol (cy)	Deliv Calc Vol	Monitored	Fire Intensity	SRI	Early Date	Late Date	Pre 8-40	9-56/9-57	9-64	9-69	9-73	10-87	8-88
ns	16	P	H	JD	90	S	IG	DS	V							0	0		M		1900	1940	V	N	N		N	N	
ns	16	P	M	JD	55	S	HW	DS	P							0	0		M		1900	1940	V	N	N		N	N	
ns	18	P	H	GB	90	W	HW	RF	V							0	0		L		1900	1940	V	N	N		N	N	
ns	14	U	H	JD	55	SE	IG	DS	V	10	20	30	G	38000	9	36000	36100		M		1964	1969				E	N	N	N
ns	14	U	H	JD	55	SE	IG	DS	P	20	20	10	G	25000	9	24000	23750		M		1969	1973	V	N	N		R	N	
ns	16	U	M	GB	80	NW	IG	DS	V							0	0		L		1900	1940	V	N	N		N	N	
ns	16	U	M	JD	75	S	IG	DS	V	9	40	40	G	90	9	85	85		M		1964	1969				E	N	N	
ns	18	U	H	GB	75	NW	HW	DS	V							0	0		L		1900	1940	V	N	N		N	N	
ns	18	U	H	GB	90	S	IG	RF	V							0	0		M		1900	1940	P	N	N		N	N	
ns	18	U	H	GB	75	SE	IG	RF	V							0	0		L		1900	1940	P	N	N		N	N	
s	56	N	H	JD	75	SW	IG	DS	V	15	11	16	G	17125	9	16000	16269?		M	19	1964	1969	V	N	N	R	N	N	
s	3	N	H	JD	90	SW	DC	DT	V	6	40	20	G	300	9	0	270		M	53	1900	1940	P	N	N		N	N	
s	5	N	H	OG	10	NW	DC	RF	V							0	0		L	OO1	1900	1940	V	N	N		N	N	
s	6	N	H	GB	75	SE	IG	DS	X							0	0		L	19	1900	1940	P	N	N		N	N	
s	7	N	H	JD	90	SW	DC	DT	V	6	57	20	G	428	9	0	385		M	53	1900	1940	P	N	N		N	N	
s	8	N	H	OG	75	NW	DC	RF	V							0	0		L	OO1	1900	1940	P	N	N		N	N	
s	9	N	H	JD	90	SW	IG	DS	V							0	0		M	53	1900	1940	P	N	N		N	N	
s	10	N	H	JD	90	SW	IG	DS	V							0	0		M	53	1900	1940	P	N	N		N	N	
s	11	N	H	JD	90	SW	DC	DT	V							0	0		M	53	1900	1940	P	N	N		N	N	
s	19	N	H	JD	75	N	DC	DT	V							0	0		L	051U	1900	1940	V	N	N		N	N	
s	20	N	H	JD	75	NE	IG	DS	P	8	70	50	G	180	5	90	90		L	051U	1900	1940	P	N	N	N	N	N	
s	21	N	H	JD	75	N	IG	DT	V	12	65	40	G	19500	10	19500	19500		L	O19	1964	1969				E	N	N	
s	22	N	H	JD	55	NW	IG	DT	P	10	25	50	G	780	9	74000	741		L	O51O	1940	1956		E	N		N	N	
s	23	N	H	JD	75	NW	IG	DS	P							0	0		L	O19	1900	1940	V	N	N		N	N	
s	24	N	H	JD	75	N	HW	DS	V							0	0		L	051U	1900	1940	V	N	N		N	N	
s	25	N	H	JD	75	NW	DC	DT	V	6	100	20	G	750	9	710	712		L	O1	1964	1969				E	N	N	
s	26	N	H	JD	75	N	DC	DT	V							0	0		L	O51U	1900	1940	V	N	N		N	N	
s	27	N	H	JD	75	N	DC	DT	V							0	0		M	O51U	1900	1940	V	N	N		N	N	
s	28	N	H	JD	60	NE	HW	EF	V							0	0		L	O51U	1900	1940	V	N	N		N	N	
s	29	N	H	JD	75	NW	DC	DS	V	9	25	25	M	270	9	260	256		L	O14	1900	1940	P	N	N	N	N	V	
s	30	N	M	JD	55	NE	HW	EF	V							0	0		L	O51	1900	1940	V	N	N		N	N	
s	31	N	H	JD	75	NW	HW	DT	V							0	0?		L	O51	1900	1940	V	N	N		N	N	
s	32	N	H	JD	55	N	DC	DT	V	9	350	50	G	98693	9	88800	88824		L	O19	1964	1969				E	N	V	
s	33	N	H	JD	75	N	IG	DS	X	10	40	20	G	60	9	50	54		L	O19	1957	1964			E		N	N	N

WS	LS #	Site Cond	WS Sens	Geo	% Slope	Aspect	Landform	Slide Type	Slope Shape	Depth (ft)	Slope length (ft)	Width (ft)	Slope Location	Vol Failed (cy)	Deliv %	Deliv Vol (cy)	Deliv Calc Vol	Monitored	Fire Intensity	SRI	Early Date	Late Date	Pre 8-40	9-56/9-57	9-64	9-69	9-73	10-87	8-88
s	34	N	H	GB	75	SE	IG	DS	P							0	0		L	O51	1900	1940	P	N	N		N	N	
s	35	N	H	GB	60	NW	HW	RF	V	30	700	15	M	150000	8	120000	120000		L	OO1	1964	1969	V	N	N	E	N	N	
s	36	N	H	GB	70	W	IG	RF	V							0	0		L	19	1900	1940	P	N	N		N	N	
s	37	N	H	GB	75	SE	IG	DS	P							0	0		L	19	1900	1940	V	N	N		N	N	
s	38	N	H	GB	70	S	LD	DS	P							0	0		L	OO8	1900	1940	V	N	N		N	N	
s	39	N	H	GB	60	S	LD	DS	V	9	20	20	G	250	10	22500	250		L	OO8	1964	1969	V	N	N	E	N	V	
s	40	N	M	GB	60	N	IG	RF	V							0	0		M	19	1900	1940	P	N	N		N	N	
s	41	N	M	GB	65	NW	DC	RF	V							0	0		M	19	1900	1940	P	N	N		N	N	
s	42	N	M	GB	75	N	IG	DS	P							0	0		M	19	1900	1940	P	N	N		N	N	
s	43	N	H	GB	90	S	IG	RF	V							0	0		M	19	1900	1940	P	N	N		N	N	
s	45	N	M	JRGV	65	SW	HW	DS	V							0	0		M	19	1900	1940	V	N	N		N	N	
s	46	N	M	JRGV	65	SW	DC	DS	V							0	0		M	19	1900	1940	V	N	N		N	N	
s	47	N	M	JRGV	75	SW	DC	DS	V							0	0		M	19	1900	1940	V	N	N		N	N	
s	48	N	M	JRGV	60	SW	DC	DS	V							0	0		M	19	1900	1940	V	N	N		N	N	
s	49	N	M	JRGV	55	SW	HW	DT	V	6	43	18	G	290	2	55	58	?	H	19	1964	1969				E	N	N	
s	53	N	H	JD	90	SW	DC	DS	V							0	0		H	19	1900	1940	V	N	N		N	N	
s	55	N	H	JD	90	SW	IG	DS	V							0	0		M	19	1900	1940	V	N	N		N	N	
s	62	N	?	JD	90	SE	DC	DS	V	25	17	70	M		9	0	0		M		1900	1940	V	N	N		N	N	
s	63	N	H	JD	60	S	IG	DS	V							0	0		M		1900	1940	P	N	N		N	N	
s	66	N	H	JD	66	NE	IG	DT	V							0	0		L		1900	1940	V	N	N		N	N	
s	68	N	H	JD	10	NW	IG	DS	V							0	0		L		1900	1940	V	N	N		N	N	
s	69	N	H	JD	65	SE	IG	DS	P							0	0		M		1900	1940	V	N	N		N	N	
s	70	N	H	JD	90	SE	IG	DS	P	12	20	50	G	750	10	750	750		M		1964	1969				E	N	N	
s	71	N	M	JD	65	S	IG	DS	P							0	0		M		1900	1940	V	N	N		N	N	
s	72	N	H	JD	85	NW	IG	DS	V							0	0		L		1900	1940	V	N	N		N	N	
s	73	N	H	JD	55	SW	DC	DS	V	15	10	75	G	704	6	420	504		L		1940	1956		E 90	N		N	R 10	
s	73	N	H	JD	55	SW	DC	DS									56				1973	1987						R 10	
s	74	N	M	JD	85	S	IG	DS	V							0	0		L		1900	1940	V	N	N		N	N	
s	75	N	H	JD	10	S	IG	DS	V							0	0		L		1900	1940	V	N	N		N	N	
s	76	N	H	JD	90	SW	IG	DS	P							0	0		L		1900	1940	V	N	N		N	N	
s	77	N	H	JD	75	SE	DC	DT	V							0	0		M		1900	1940	V	N	N		N	N	
s	78	N	H	JD	75	SW	IG	DS	V							0	0		L		1900	1940	V	N	N		N	N	
s	79	N	H	JD	90	S	IG	DS	V							0	0		L		1900	1940	V	N	N		N	N	
s	80	N	H	JD	90	SE	IG	DT	V							0	0		L		1900	1940	V	N	N		N	N	

WS	LS #	Site Cond	WS Sens	Geo	% Slope	Aspect	Landform	Slide Type	Slope Shape	Depth (ft)	Slope length (ft)	Width (ft)	Slope Location	Vol Failed (cy)	Deliv %	Deliv Vol (cy)	Deliv Calc Vol	Monitored	Fire Intensity	SRI	Early Date	Late Date	Pre 8-40	9-56/9-57	9-64	9-69	9-73	10-87	8-88
s	81	N	H	JD	90	SE	IG	DS	P	10	12	10	G	780	10	780	780		M		1964	1969				E	N	N	
s	82	N	H	JD	90	SE	IG	DS	P	10	15	10	G	94	10	940	94		M		1964	1969				E	N	N	
s	83	N	H	JD	10	SE	IG	DS		8	30	15	G	22533	9	21000	21406				1973	1987						R	
s	83	N	H	JD	10	SE	IG	DS	V							0	0		M		1900	1940	V	N	N		N	R	N
s	84	N	H	JD	75	S	IG	DS	P	12	30	10	G	22533	10	23000	22533		M		1973	1987						E	N
s	85	N	H	JD	75	S	IG	DS	V								0		M		1900	1940	P	N	N		N	N	
s	86	N	H	JD	60	S	IG	DS	V								0		M		1900	1940	P	N	N		V	N	
s	87	N	H	JD	60	S	IG	DS	P	15	175	50	G	82000	9	78000	77900		L		1940	1956	V	R 90	N		V	R 10	
s	88	N	H	JD	75	S	DC	DS								460	0				1969	1973					R50		
s	88	N	H	JD	75	S	DC	DS	X	12	26	50	G	970	9	460	0		M		1964	1969				E 50	R 50	N	
s	89	N	H	JD	60	S	DC	DT	V	9	137	20	G	15500	9	14000	13950		L		1940	1956	V	R 25	R 75	R 75	N	N	
s	90	N	H	JD	75	S	IG	DS	P							750	0		M		1900	1940	V	N	N		N	N	
s	91	N	H	JD	75	N	IG	DS	V	10	13	50	G	500	9	422	475		L		1964	1969				E	N	N	
s	92	N	H	JD	90	S	IG	DS	V	2	35	30	G	13000	9	12500	12350		L		1900	1940	P	N	R	N	N	N	
s	93	N	H	GB	10	N	IG	DS	V							0	0		L		1900	1940	V			R	N	N	
s	93	N	H	GB	10	N	IG	DS		9	40	46	G	850	9	800	807				1964	1969				R			
s	94	N	H	GB	90	SE	IG	DS	V	6	12	10	G	470	10	470	470		L		1940	1956	V	R	N		N	N	
s	95	N	H	GB	85	SE	IG	DS	P	10	60	50	G	190	10	190	190		L		1940	1956		E	N		V	N	
s	96	N	H	GB	10	SE	IG	DS	P							0	0		L		1900	1940	V	N	N		N	N	
s	97	N	H	GB	90	SE	IG	DS	P	10	15	10	G	940	9	890	893		L		1900	1940	V	N	N		N	N	
s	98	N	H	GB	60	SE	IG	DS	P							0	0		L		1900	1940	P	N	N		N	N	
s	99	N	H	GB	60	NW	DC	DT	V							0	0		M		1900	1940	P	N	N		N	N	
s	10	N	M	JD	65	W	HW	EF	P							0	0		H		1900	1940	V	N	N		N	N	
s	10	N	H	JD	55	SE	IG	DS	V	12	50	44	G	12400	9	11800	11780		M		1964	1969				E	N	N	
s	10	N	H	JD	75	SE	IG	DS	P	15	10	10	G	10000	9	950	950		M		1964	1969				E	N	N	
s	10	N	M	JD	60	SE	DC	DS	V	9	50	50	G	140	10	140	140		L		1964	1969				E	N	N	
s	10	N	H	JD	60	SE	IG	DS		15	57	10	G	50667	9	48133	48134				1964	1969				R			
s	10	N	H	JD	60	SE	IG	DS	P							0	0		M		1900	1940	V			R	N	N	
s	10	N	H	JD	75	SE	IG	DS	P	15	15	60	G	884	9	840	840		M		1964	1969				E	N	N	
s	10	N	H	JD	90	SE	IG	DS	V	20	17	12	G	24000	9	14929	22800		M		1964	1969	V 35	N	N	R 65	N	N	
s	10	N	H	JD	75	SW	IG	DS	V							0	0		M		1900	1940	V	N	N		N	N	
s	11	N	H	JD	75	SW	IG	DS	V							0	0		M		1900	1940	V	N	N		N	N	
s	11	N	H	JD	65	SW	LD	DS	P							0	0		M		1900	1940	V	N	N		N	N	
s	11	N	H	JD	90	S	DC	DT	V							0	0		M		1900	1940	V	N	N		N	N	

WS	LS #	Site Cond	WS Sens	Geo	% Slope	Aspect	Landform	Slide Type	Slope Shape	Depth (ft)	Slope length (ft)	Width (ft)	Slope Location	Vol Failed (cy)	Deliv %	Deliv Vol (cy)	Deliv Calc Vol	Monitored	Fire Intensity	SRI	Early Date	Late Date	Pre 8-40	9-56/9-57	9-64	9-69	9-73	10-87	8-88
s	11	N	H	JD	75	SE	DC	DS	V	12	100	50	G	37500	9	33800	33750		M		1940	1956	V	R 1/3	N	R 2/3	N	N	
s	11	N	H	JD	90	S	IG	DS	P							0	0		L		1900	1940	V	N	N		N	N	
s	11	N	H	JD	60	S	IG	DS	X	9	10	30	G	169	3	50	50		L		1940	1956		E	N		N	N	
s	11	N	H	JD	65	S	IG	DS	V							0	0		L		1900	1940	V	N	N		N	N	
s	11	N	H	JD	75	SE	IG	DS	V	10	12	50	G	390	9	400	370		L		1964	1969				E	N	N	
s	11	N	H	JD	60	SE	DC	DT	V							0	0		M		1900	1940	V	N	N		N	N	
s	12	N	M	JD	75	SE	HW	DS	V							0	0		L		1900	1940	V	N	N		N	N	
s	12	N	M	JD	75	SE	HW	DS	P							0	0		L		1900	1940	V	N	N		N	N	
s	12	N	M	JD	75	SE	HW	DS	P							0	0		H		1900	1940	V	N	N		N	N	
s	12	N	H	JD	65	SW	DC	DS	X	8	25	45	M	440	5	220	220		L		1973	1987						E	N
s	12	N	M	JD	85	SE	HW	DS	V							0	0		M		1900	1940	V	N	N		N	N	
s	12	N	H	JD	90	SW	HW	DS	V							0	0		M		1900	1940	V	N	N		N	N	
s	13	N	M	JD	55	SE	HW	DS	V							0	0		H		1900	1940	V	N	N		N	N	
s	13	N	M	JD	60	SE	HW	DS	V							0	0		H		1900	1940	V	N	N		N	N	
s	13	N	H	JD	60	SE	DC	DT	V	10	13	60	M	380	9	340	342		M		1973	1987						E	N
s	13	N	H	JD	75	SE	IG	DS	V	10	90	10	M	440	9	400	396		M		1973	1987						E	N
s	13	N	M	JD	60	SW	DC	DT	V							0	0		M		1900	1940	V	N	N		N	N	
s	13	N	H	JD	75	NE	IG	DS	V								0		M		1900	1940	P	N	N		V	N	
s	14	N	M	JD	90	SE	HW	DS	P							0	0		L		1900	1940	V	N	N		N	N	
s	16	N	H	JD	70	S	IG	DT	V							0	0		L		1900	1940	V	N	N		N	N	
s	25	N	H	JD	80	NE	IG	DS	V	9	50	25	G	70	10	70	70		L		1964	1969				E	N	N	
s	25	N	H	JD	80	NE	IG	DS	V	9	20	50	G	300	10	300	300		L		1964	1969	V	N	N	R	N	N	
s	12	U	H	JRGV	60	NE	DC	DS	V	12	10	50	G	380	9	360	361		M	19	1964	1969				E	N	N	
s	13	U	M	JRGV	60	NE	IG	EF	V	6	27	20	G	20300	9	19000	19285		M	19	1973	1987						E	N
s	18	U	H	JD	75	NW	DC	DT	V	6	120	20	M	703	9	700	668	?	M	O14O	1940	1956	V	R	N	N	N	N	
s	50	U	H	JRGV	55	SW	IG	DS	P	9	50	30	G	84	8	70	67		H	19	1940	1956		E	N		N	N	
s	51	U	H	JD	75	NE	IG	DS	P	15	28	10	G	27000	9	24000	24300	?	M	19	1940	1956		E	N		N	N	
s	52	U	H	JD	90	SW	IG	DS	P	20	17	15	G	13033	9	0	12381		M	19	1900	1940	V	N	N		N	N	
s	54	U	H	JD	90	SW	DC	DS	V							0	0		M	19	1900	1940	V	N	N		N	N	
s	57	U	H	JD	75	SE	IG	DS	P	12	70	60	G	315	9	300	376		M		1940	1956		E 1/3	E 2/3	N	N	N	
s	57	U	H	JD	75	SE	IG	DS									752				1956	1964			E 2/3				
s	58	U	H	JD	75	SE	IG	DS	P	12	14	50	G	537	9	510	510		M		1900	1940	V	N	N		N	N	
s	59	U	H	JD	47	NE	IG	DT	V							0	0		M		1900	1940	V	N	N		N	N	
s	60	U	H	JD	90	N	IG	DS	P	20	14	20	G	17500	9	31500	16625		M		1964	1969				E	N	N	

WS	LS #	Site Cond	WS Sens	Geo	% Slope	Aspect	Landform	Slide Type	Slope Shape	Depth (ft)	Slope length (ft)	Width (ft)	Slope Location	Vol Failed (cy)	Deliv %	Deliv Vol (cy)	Deliv Calc Vol	Monitored	Fire Intensity	SRI	Early Date	Late Date	Pre 8-40	9-56/9-57	9-64	9-69	9-73	10-87	8-88
s	61	U	H	JD	60	SE	IG	DS	V	60	90	40	G	135200	9	963300?	128440		M		1964	1969	V	N	N	R 75	N	N	
s	64	U	H	JD	10	NE	DC	DT	V	12	460	20	M	53973	9	50000	51274		M		1964	1969	V	N	N	R	N	N	
s	65	U	H	JD	67	NE	IG	DT	V	12	230	20	G	32711	9	29439	29440		M		1964	1969	V	N	N	R	N	N	
s	67	U	H	JD	75	W	IG	DS	V							0	0		L		1900	1940	V	N	N		N	N	
s	10	U	H	JRGV	65	SE	IG	DS	P	12	10	50	G	380	10	380	380		M		1940	1956		E	N		N	N	
ss	1	N	M	GB	90	SW	IG	DS	X	20	93	60	G	700	9	660	665		L	O99	1964	1969				E	N	N	
ss	2	N	M	GB	60	SE	IG	DS	X	15	85	50	G	399	9	380	379		L	19	1957	1964			E	N	N	N	
ss	4	N	H	JDV	84	SW	IG	RF	P	10	25	10	G	160	9	0	152		M	19	1900	1940	P	N	N		N	N	
ss	14	P	H	JD	75	W	DC	DS	V	9	70	40	M	120	1	12	12		M	19	1940	1956		E	N		N	N	
ss	15	U	H	JD	75	E	IG	DS	X	20	14	15	G	26000	10	26000	26000	M	M	O51	1900	1940	P	N	N		N	N	N
ss	16	U	H	JD	55	E	DC	DT	V	10	125	30	G	23000	10	23000	23000	M	M	O55	1900	1940	V	N	N	N	N	N	
ss	17	U	H	JD	55	NE	DC	DT	V	10	125	30	G	23000	10	23000	23000	M	M	O55	1940	1956	V	R	N	N	N	N	